Jones Digital Century

American Telephone & Telegraph Company (AT&T)

One of the largest corporations in the world, offering long-distance telephone and telecommunications services, and information processing and storage systems. Headquartered in New York City, AT&T is now and always has been at the forefront of telecommunications technology.

AT&T was incorporated in 1885 with Theodore N. Vail as President. Originally a subsidiary of the Bell Telephone Company (of which Vail was General Manager), AT&T's business was building long distance lines for its parent company, which telephone inventor Alexander Graham Bell had founded. Other notable Bell Company subsidiaries included the Western Electric manufacturing group and the Mechanical Unit which became Bell Telephone Laboratories. In 1890, AT&T absorbed American Bell, becoming the Bell System's central organization. Within two years, there were 10,000 AT&T employees servicing 240,000 telephones in America.

After an earlier retirement in 1889, Theodore Vail returned to AT&T as President in 1907 following the deaths of his wife and son in Argentina. During his second tenure which lasted until 1919, Vail successfully elevated the company to the leadership position it held until 1984. His brilliant tactics included joining forces with hundreds of local firms who were AT&T's competition when the original Bell patents expired; consolidating the firms into state and regional organizations; developing the first transcontinental telephone lines; acquiring working control of Western Union; and cultivating the company's relationship with the news media, among others.

In 1918, Congress nationalized AT&T under the U.S. Post Office Department, but the company returned to private ownership the next year. The Graham-Willis Act of 1921 confirmed that AT&T was a natural monopoly, that it must provide long distance service to independent companies, and that it could buy these companies only if the Interstate Commerce Commission (ICC) approved the purchase.

Controlling the rights to Lee de Forest's crucial Audion tube, AT&T entered radio broadcasting in the 1920's. An AT&T station, WEAF in New York, broadcast the very first commercially sponsored radio program in 1922. This new practice of advertising on the radio shocked many broadcasters who initially considered it vulgar. By 1925, AT&T owned 26 radio stations reaching from the East Coast to Kansas City. With its sophisticated system of lines, AT&T was able to share programs among its stations creating an early "network" scenario. AT&T also was involved in the early growth of television. In 1920, AT&T demonstrated a two-way picturefone in New York City, and in 1928, the company transmitted the first motion picture by wireless.

With passage of the Communications Act of 1934, the ICC was replaced by the Federal Communications Commission (FCC), which investigated Bell corporate practices from 1935-1939. As a result, in 1949, the Justice Department sued to separate Western Electric from AT&T under the Sherman Anti-Trust Act. Although this resulted in restrictions on AT&T's monopolistic practices, Western Electric remained a subsidiary.

During this time, AT&T entered a heated competition with Western Union to develop a microwave beam system for television. Then Western Union requested approval from the FCC for its fledgling microwave system to be interconnected with the massive Bell System of lines. The FCC investigated this request for eight long years, virtually halting Western Union's progress in this area. During the lengthy delay, AT&T was able to take the lead and develop its own television monopoly. By 1958, AT&T had 68,000 miles of TV circuits and almost 20 million miles of telephone circuits within its microwave system.

AT&T also took the lead in the 1960's space race, building the first satellite not owned by the government. Called the Telstar, it was launched from Cape Canaveral in July 1962 and relayed the first live television broadcast across the Atlantic. Telstar also transmitted other types of communications, including telephone, telegraph, telephoto, data and facsimile.

In 1974, a second antitrust suit was brought against AT&T, whose telephone lines, microwaves, satellites and cables linked global communication in a $4 billion business. History's largest antitrust suit was ultimately presided over by Judge Harold Greene, and in 1982, it resulted in the mandate that AT&T divest itself of its 22 local Bell System operating companies. During the lengthy and grueling lawsuit, AT&T spent nearly $300 million to defend itself.

After official divestiture on January 1, 1984, the 22 local operating companies were reorganized as subsidiaries of seven new regional holding companies: Ameritech (or American Information Technologies, Inc.), Bell Atlantic, BellSouth, NYNEX, Pacific Telesis Group, Southwestern Bell Corporation (now SBC Communications) and U S West. The local operating companies retained their rights to publish the lucrative Yellow Page directories. The regional holding companies received the rights to use the Bell name and its trademark blue bell, and also were licensed by the FCC for cellular mobile telephone service.

After divestiture, AT&T gradually was able to enter some previously prohibited fields, such as data processing, computer communications and equipment sales. In these new arenas, AT&T was characteristically aggressive. In 1985, AT&T garnered a very lucrative contract to produce and service a new type of personal computer for the U.S. Defense Department. In 1988, the company announced plans to acquire 20% of Sun Microsystems to help further develop its breakthrough UNIX computer-operating systems for office automation. That same year, AT&T built a semiconductor plant near Madrid, Spain and acquired Paradyne Corporation, a data communications equipment manufacturer.

In his continuing jurisdiction over AT&T through the controversial antitrust suit, Judge Greene ruled in 1989 that the company could enter the previously banned electronic publishing business. In 1991, AT&T purchased the NCR Corporation, a global computer maker, to help reinforce its position in that burgeoning industry. The same year, the company introduced a tablet input notebook computer that could recognize handwriting. In addition to all this, AT&T benefited from the phenomenal growth of computers in various communication networks.

Today, AT&T remains a giant in the telecommunications business, continually updating its technology and facing the competition head-on, a standard set by its first President, Theodore Vail, over a hundred years ago.

u contributed by Kay S. Volkema

Editor's Notes:
Judge Harold Greene has been asked by the Justice Department to eliminate the Modified Final Judgment of 1982. The Telecommunications Act of 1996 provides new guidelines for telecommunications regulation, and the Department of Justice believes that Judge Greene's involvement with the issue is no longer necessary.

Allen, Robert Eugene (1935 –)

American business executive; currently Chairman and Chief Executive Officer of American Telephone and Telegraph (AT&T).

Robert E. Allen was born in Joplin, Missouri, on January 25, 1935. He grew up in Indiana and spent time during his youth working on a farm and as part of a railroad gang. Allen played end on the football team while attending Indiana's Wabash College. His college sweetheart, Betty, became his bride in August 1956. After graduating from Wabash in 1957, Allen joined Indiana Bell as a Traffic Engineer. This was the beginning of his lifelong career with AT&T.

During the 1960's and 1970's, Allen served in increasingly more responsible positions throughout the AT&T system. He had already demonstrated his no-nonsense business approach when he attended the Harvard Business School Program for Management Development in 1965. In 1978, he moved to AT&T corporate headquarters as Business Services Vice President. He became President of the Chesapeake and Potomac Telephone Companies in 1981 and Chairman in 1983.

In July 1983, prior to AT&T's impending divestiture, then-AT&T Chairman Charles L. Brown brought Robert Allen back to AT&T headquarters and made him Chief Financial Officer. On January 1, 1984, Allen became Executive Vice President — Corporate Administration and Finance. A little more than a year later, Allen was named Chairman and Chief Executive Officer of AT&T Information Systems. At the time, Information Systems was floundering. The soft-spoken Allen lived up to his reputation as an effective cost-cutter by, in part, slashing over 20,000 jobs.

Robert Allen was named AT&T President and Chief Operating Officer in 1986 and Chairman and Chief Executive Officer in April 1988. In his years at AT&T's helm, Allen has decentralized management, shaved costs, held off long distance competitors and increased profits. He is credited with reviving the telecommunications giant and guiding it into the future with his strong vision and focused management style.

Allen believes AT&T's strengths as the leader in long-distance telephone service and as a major manufacturer of telecommunications equipment make it ideally suited to deliver all forms of information to people worldwide. He plans to assemble under one roof the necessary resources for a global network to carry voice and data, including the equipment to run it and the sophisticated devices that hook up to it. His vision is for AT&T to build computer networks that are as efficient, as easy to use, and as accessible as today's telephone system.

Robert Allen's characteristically thoughtful style was reflected in a comment following his maneuvering of AT&T through the difficult acquisition of NCR in 1991. As a result of the purchase, AT&T became one of the nation's largest computer manufacturers. During tough negotiations preceding the acquisition, Allen learned that NCR's Chairman shared his love of good cigars. Later, he wondered aloud if the two might have reached agreement earlier if they had smoked a cigar together.

But the soft-spoken chairman’s most ambitious corporate restructuring came on September 20, 1995. On that date Allen announced that the AT&T board had approved his plan for a massive strategic realignment of AT&T that would split the company into three independent, publicly owned, global companies, each focused on its own segment of the $1.5 trillion global information industry. The companies will focus on communications services, product and equipment businesses except computers and computer business.

Among his other activities, Allen serves on the Board of Directors of Bristol-Myers Squibb Company, PepsiCo, Chrysler, the America-China Society, the Council on Foreign Relations, the Baldridge Foundation, and Wabash College’s Board of Trustees.

Robert E. Allen is slated to retire as AT&T’s Chairman and Chief Executive Officer in the year 2000 after nearly a half century of service.

u contributed by Susan P. Sanders

A/B Switches

An internal or external switch that allows a user to select either of two signal sources or route a signal to one of two destinations.

A/B switches can be used in telephony, cable television, broadcast television, computers and other electronic services to switch between input sources or select one of two destinations for the output. For example, cellular phones can be switched between a wireless carrier or a wireline carrier when roaming away from home. A cable television A/B switch can let a user select a cable input or an antenna input, or it can allow a user to route a cable signal to a VCR for recording or to a television set for viewing. In broadcast television, an A/B switch can be used to switch between signal sources, such as camera number one and camera number two. Computer users can use an A/B switch to select one of two possible input devices, for example, a keyboard or a scanner, or to route a signal to one of two output devices, such as a printer or a plotter.

An external A/B switch has three ports: one marked "A," one marked "B," and one that can be connected to either the input source or the destination. To use the A/B switch to select from one of two possible signal sources, one source would be connected to the "A" port and one to the "B" port. The destination device would be connected to the third port, which in this case would function as an output port. By pressing the "A" switch, the signal from that source would be transmitted to the destination. Pressing the "B" switch would change the source, enabling its signal to be routed to the destination.

To use the A/B switch as a routing device to switch an input signal to one of two possible destinations, the input source would be connected to the single port. Each of the two possible destination devices would be connected to the "A" and "B" ports. Pressing the "A" or "B" switch routes the incoming signal to the device connected to that port.

A/B switches can have more than two switches, for example "A," "B," and "C." A switch with three selections can let a user choose a cable signal, video game or VCR as the signal source to a television set. In any A/B switch, no matter how many switches it contains, when one source or destination is selected, all others are disconnected. An A/B switch cannot be used to split a signal and send it to two devices simultaneously.

u contributed by Paul Stranahan

American Broadcasting Company (ABC)

The American Broadcasting Company (ABC) is the youngest of the three established broadcast television networks. After years of frustration and struggle, ABC is the undisputed gold medal winner. Like an athlete coming from an underprivileged background, ABC has had to work twice as hard to get there. ABC is headquartered in New York City.

ABC owes its beginnings to the National Broadcasting Company (NBC). In 1927 the Radio Corporation of America (RCA), the parent of NBC, had two affiliates that were geographically too close to each other. One was in New York and the other in Newark, New Jersey. NBC solved the duplication problem by forming a second network. The stations hooked to the New York station became the Red Network and the stations hooked to Newark became the Blue Network. But both belonged to NBC. The two colors were the simple way the switchboard kept the networks separate.

In 1943 the Federal Communications Commission (FCC) ordered NBC to divest, or sell, one of its networks. Edward J. Noble, who had made millions in Life Savers Candy, bought the Blue Network under the parent name of the American Broadcasting System. In the mid 1940's Noble changed the parent name to American Broadcasting Company, Inc. (ABC) and merged the Blue Network into it.

In 1953 ABC merged with United Paramount Theaters, and the company was then known as American Broadcasting – Paramount Theaters, Inc. United Paramount President Leonard Goldenson was also named President of the new company. With this merger, ABC found itself the owner of many movie theaters all over the country. The affiliation with the film industry would prove to be very beneficial for ABC.

The then ten-year-old network, always struggling for on-air talent, revenues, and programming, fought with the DuMont Network, an equally weak television network. Eventually in 1955 DuMont folded and that left NBC as the oldest, the Columbia Broadcast System (CBS) the strongest, and ABC as the weakest network. At the time the industry was referred to as a 2 1/2 network economy.

Like all businesses at the bottom, ABC was forced to be more creative, more determined, more willing to try. Or it had to simply cease. Two programming practices initiated by ABC forced wide-spread and dramatic changes in the industry. The first was ABC's Hollywood connection. In the mid 1950's ABC brought major film studios into television production which, in effect, brought Hollywood to television. This forced the other networks to go from live shows to filmed and later videotaped productions. The second was selling prime time commercials on a spot basis, which in turn brought about the end of program sponsorships. Program sponsorships would eventually have stopped; in fact NBC's Pat Weaver is generally credited with ending sponsorships. But ABC certainly hastened the end in that it had the air-time inventory, could charge less and therefore appeal to smaller advertisers. Earlier, in the radio-only era, ABC developed daytime game shows. In addition, ABC also allowed programs to be taped instead of broadcast live. This accommodation for the talent, Bing Crosby for example, probably helped the network look more attractive to both agents and advertisers.

One of ABC’s Hollywood connections gave ABC its first hit television show, *Disneyland*. *The Mickey Mouse Club* was the second hit. Soon Warner Brothers and MGM began producing ABC shows. And while ABC had a taste of success, the network still lagged behind in strong and consistent shows and talent. ABC was infamous for producing one-season hits.

In 1965 the company name was changed to American Broadcasting Companies, Inc. and that year both NBC and CBS made the move to all-color. This was costly competition that ABC simply did not need. In order to make the extremely expensive switch to color, ABC was forced to sell some properties as well as its investment in Disneyland. By 1967 all three networks were all-color and ABC had an agreement to merge with International Telephone and Telegraph Corporation (ITT). For the next thirteen months the merger was tied up in a governmental knot and finally the deal was called off.

The following years were spent fending off take-overs, re-organizing management and taking a hard look at programming and technology. Fortunately for ABC, the FCC changed the Prime Time Access Rule in 1971. This forced all of the networks to cut 30 minutes from their prime-time programming and provide just three hours of shows each night (four on Sundays). ABC used the new rule to its advantage and cut losses to build a leaner and stronger product.

Instant replay was developed by ABC engineers in 1961. This, plus an under-developed market in sports programming, allowed ABC to go for the gold. *Monday Night Football*, *Wide World of Sports*, and the Olympics all played a huge part in ABC’s struggle for strength. The undisputed mastermind of this sports strategy was Roone Arledge, President of ABC Sports (l-r: Don Meredith, Jim McKay, Joe Louis, Roone Arledge). Arledge’s contributions during his 18 years with the sports division include hand-held cameras, close-ups, shot-gun mikes, slow motion, instant replay and mini-cams on skis and race cars. A lesser-known man, Julius Barnathas, was the head of engineering and operations. He is the recognized genius who, alongside Arledge, worked out the logistical nightmare that is known as sports coverage.

By 1976, with programming targeted to a younger audience and leading in sports coverage, ABC won in the ratings. The network finally was successful in upsetting the big, strong, previously un-stoppable CBS. After more than 30 years, ABC was on top.

In addition to Arledge, people like Frederick Pierce, President of ABC Television; Fred Silverman, program chief; and programmer Brandon Stoddard all contributed to bringing ABC up from the bottom. Mini-series and their consecutive-night airings, 80% ownership of cable’s ESPN plus other cable outlets, and narrowly-targeted programming were all ideas introduced by the leaders at ABC. The struggle, while worth the effort, was not over. By 1984 ABC had fallen to number three again. Chairman Goldenson contacted station group Capital Cities Communications to discuss a merger. But in an odd twist, ABC was bought by the much smaller Capital Cities in 1986. Thomas Murphy, Chairman and CEO of Capital Cities, became the CEO of the new company, Capital Cities/ABC, Inc.

Murphy had been hired by Hudson Valley Broadcasting in 1954. His job was to rescue a television station in Albany, New York. Hudson Valley continued to grow and went public as Capital Cities Communications in the mid 1950's. The founder of the company kept busy buying and selling property while Murphy learned the business and ran the company.

During 1985 and 1986 all three networks changed hands, but ABC was the only company now owned by broadcasters, yet another alliance that would be favorable to ABC. Capital Cities was a well-run, well-respected, highly profitable corporation. Four of Capital Cities' seven television stations were ABC affiliates. With Murphy at the head of Capital Cities/ABC, Inc. and Daniel Burke, also from Capital Cities, ABC did nothing but gain strength. The new leadership at Capital Cities/ABC insisted on scrutinizing ABC's interests in the same detailed, hands-on way Capital Cities did. Even though Capital Cities Communications was much smaller than ABC, it was the company that was profitable and, from a business stance, management knew what they were doing.

When the other networks were cutting their news divisions, ABC's Roone Arledge, now head of the news department, spent money and raked in profits. Robert Iger, like Arledge, came from the sports side and then moved into the entertainment division. In 1992 Iger was named President of the ABC Television Network Group. Meanwhile, in a case of corporate musical chairs, Burke retired from the company in 1994 but only after he replaced Murphy as CEO in 1990. When Burke retired in 1994, Murphy stepped back into the fray as the CEO and Chairman. After a long and profitable relationship with Burke, Murphy started grooming Iger to take over. In September 1994, Iger was named President and Chief Operating Officer of Capital Cities/ABC, and if the Capital Cities' success trend holds, Iger should have no problem leading the way.

u contributed by Michele Messenger

Editor's Notes:
In January, 1996, Disney was granted permission by the FCC to purchase Capital Cities/ABC for $19 billion. The purchase will make Disney the largest media conglomerate, incorporating moviemaking, television production, radio stations, and newspaper publishing under the Disney name.

Murphy, Thomas S. (1925 –)

American businessman and television executive, currently Chairman and Chief Executive Officer (CEO) of Capital Cities/ABC, Inc., which operates the American Broadcasting Company (ABC), the country's third television network. Capital Cities/ABC's other holdings include television and radio stations, newspapers, magazines and cable systems.

In the mid-1950's Murphy was asked to help the Hudson Valley broadcasting company turn around its ailing Albany, New York, television station. When Murphy took over the station the paint was peeling off the exterior of the building. Knowing the message the peeling paint conveyed, Murphy had the building painted. But also knowing he didn't have funds to do the whole building, he ordered the painters to just do the two sides of the building that faced the road. Message clear —expenses cut. So began Murphy's legendary status as a no-nonsense, financially shrewd industry strategist. Once the Albany station was in Murphy's capable hands, owner Frank Smith bought more stations. Hudson Valley was renamed Capital Cities Communications (Cap Cities) and Murphy was elected a Director. In 1964 Murphy was named President of Capital Cities and four years later, under his strong management, the company went into the publishing business.

Murphy, along with his right-hand-man Daniel B. Burke, forged Capital Cities into a highly profitable and well-respected business. Murphy and Burke were a unique pair in American business. They trusted and complemented each other. In the mid-1980's when ABC Chairman Leonard Goldenson was trying to prevent his company from being bought, he discussed a merger with Murphy. Goldenson intended to merge the smaller Capital Cities into the larger ABC. But after months of talk, speculation and planning the small company, Capital Cities with its four ABC stations (seven stations total), bought the network instead. The deal was finalized in January 1986. Highly regarded as an excellent businessman, Murphy rose to the network forefront when Capital Cities Communications became the parent of ABC.

Murphy was CEO of the new company until 1990. From 1990 to 1994 he was Chairman of the Board while Burke served as CEO. In 1994, Burke retired and Murphy was once again named CEO as well as Chairman.

When Murphy and Burke took over ABC in 1986, there was cause for concern among the network employees. ABC had always been the weakest network until 1976 when, with excellent planning during a time of strong profits, it climbed to the top. However, times were changing in the industry. For most of the three networks, the television industry had always been lavish as well as lucrative. By the mid-1980's, cable, syndications and VCRs were causing major viewership slippage. The change in viewership numbers plus a somewhat weakened advertising economy caused all three networks to tighten their belts. With the ABC acquisition, Capital Cities took on some enormous and spiraling expenses. Under Murphy that stopped. Many expenses were cut immediately. Murphy's bottom-line improvement style was to make the acquisition pay with trimmed expenses and then make improvements. Such was his plan for ABC. However, when he noticed an "us versus them" attitude among his own Cap Cities employees, he quickly took steps to turn the situation around.

Murphy's ABC plans included continued cost-cutting and expense-watching, while insisting that employees take responsibility for their budgets and success. Typically, network TV division heads didn't keep track of dollars and budgets on a daily basis. That changed under Murphy's rules. Murphy taught his new executives that they would not get into trouble for being wrong but they would get into trouble for not admitting mistakes

As government rules regarding production and syndication are being relaxed, Murphy and the other network leaders are planning to own more and more of their network programming in order to ensure long-term higher profits. In the meantime, a joint venture with a studio or other partnerships may be in the cards for ABC and Murphy. Regardless, with Tom Murphy heading Capital Cities/ABC, Inc., every opportunity for success will be explored.

u contributed by Michele Messenger

Adelphia Communications Corporation (Adelphia Cable)

Founded in 1952 by John J. Rigas, Adelphia Communications Corporation is one of the ten largest cable television operators in the United States. It has more than 1.3 million cable television subscribers with systems in 11 states.

The history of Adelphia Cable dates back to 1948 when it began as a small, private service to rural towns in Pennsylvania. Because of the mountainous terrain, many homes in the area could not receive traditional broadcast TV signals. This early cable system included a large antenna situated on a high peak, which could receive these broadcast signals and then re-transmit them from the mountain top into private homes.

In 1952, John Rigas, a recent graduate of the Rensselaer Polytechnic Institute in Albany, New York, bought the system for the sum of $100. Rigas and several other citizens then built the system for the small community of Coudersport, Pennsylvania, for approximately $80,000. The original expanded system had two channels, which delivered signals from Altoona and Johnstown, Pennsylvania.

Rigas, and his brother, Gus, launched a second endeavor in 1956 in Wellsville, New York, their hometown. These two systems became the foundation of Adelphia Cable. Company history detailing the early days of the organization indicates that Jerrold Electronics, founded by Milton Jerrold Shapp (who would later become Governor of Pennsylvania), was the equipment supplier for the company's expansion into Wellsville. It was the beginning of a long and successful working relationship between the two organizations.

At the time, Rigas was an engineer with Sylvania in Emporium, and later with Air Preheater in Wellsville. With the move into Wellsville, Rigas began devoting all of his time to the expansion of his young cable television (CATV) business.

In the early 1960's, the company grew by adding service to Punxsutawney, Reynoldsville, Sykesville and Uniontown, all communities in Pennsylvania. The technology of the new systems included 12 channels, and, with the development of terrestrial microwave, it offered delivery of signals from New York and Cleveland. Later in the decade, Rigas sold two of his systems — Wellsville and Uniontown — the only time in his career that he ever sold any of his cable operations.

The organization officially incorporated in 1972, with John Rigas and Gus Rigas becoming the two largest shareholders. The company continued its expansion into other areas of Pennsylvania and New York. In 1974, corporate headquarters for Adelphia were moved to a four-room suite above a hardware store on the Main Street of Coudersport.

The company weathered a difficult period in the mid 1970's, due to a variety of restrictions imposed on the cable television industry by the Federal Communications Commission (FCC). By the end of the decade, however, the picture for Adelphia and the future outlook for cable television, in general, brightened considerably.

During the 1980's, Adelphia began to grow once again. In early 1981, the corporate headquarters were moved again to an old church in Coudersport. During this time, it was awarded five new franchise systems and purchased 13 additional systems that became affiliates. Also during the 1980's, the company rebuilt many of its old systems and upgraded several others. By January 1986, Adelphia had reached a total of 206,000 subscribers.

Today, Adelphia Communications Corporation has 2,400 full-time employees and has cable operations in 11 states including New York, Pennsylvania, New Jersey, Vermont, Virginia, Massachusetts, Michigan, Ohio, North Carolina, South Carolina and Florida. With more than 1.3 million subscribers, the company is currently upgrading a number of its systems in order to provide viewers, at some point in the future, with digital compression and high definition television (HDTV). It is a member of Cable Television Laboratories, Inc. (CableLabs), the research and development organization exploring technological advancement for the cable television industry.

Recently, Adelphia expanded the services it offers through the launch of its subsidiary, Hyperion Telecommunications, Inc. It will offer businesses and other large telecommunications consumers alternate access to long-distance telephone service carriers. Adelphia has also joined other cable television companies in a joint venture to market Digital Cable Radio (DCR), a new premium service that provides ultra high-quality music via satellite transmission.

In addition, Adelphia is part owner of the Empire Sports Network, a regional sports channel located in Buffalo, New York. In April 1994, the company acquired 34 percent equity interest in Niagara Frontier Hockey, which owns the Buffalo Sabres National Hockey League franchise. This is an ideal relationship as the Sabres Hockey games are a staple of the Empire Sports Network. The Sabres partnership will also control the Crossroads Arena, a new sports and entertainment facility with anticipated completion by the end of 1996.

Adelphia, which is Greek for "brothers," is one of the ten largest cable television operators in the country. The company anticipates continued diversification in the services it offers and continued growth in its subscriber base.

u contributed by Valerie Switzer

Rigas, John J. (1924 –)

American cable television pioneer, entrepreneur, telecommunications executive, civic leader and preservationist. Rigas is founder and current Chairman, President and Chief Executive Officer of Adelphia Communications Corporation (Adelphia Cable), based in Coudersport, Pennsylvania.

John J. Rigas was born in Wellsville, New York, on November 14, 1924, and was raised in the same city. During World War II, he served in the Armored Infantry Division of the U. S. Army from 1943 to 1946. In 1950, he received a BS in Management Engineering from Rensselaer Polytechnic Institute in Albany, New York.

Rigas knew a good opportunity when he saw one. In 1952, shortly after he had become the new owner of the Coudersport Movie Theatre, he purchased the original cable television franchise from a local businessman for $100. Rigas and other Coudersport residents then built the community cable television system at a cost of nearly $80,000. Installation charges for this original system were $135 per hook-up, and monthly charges for service were $3.00.

Four years later, in 1956, Rigas and his brother, Gus, supervised the construction of a second cable system in their hometown of Wellsville. Together, these two systems were the foundation of Adelphia Cable. During this time, Rigas's full-time occupation was first as an engineer with Sylvania in Emporium, Pennsylvania, and later as an engineer with Air Preheater in Wellsville, New York.

Noteworthy is the fact that the primary equipment supplier for Adelphia Cable was Jerrold Electronics, founded and headed by Milton Jerrold Shapp, the future Governor of Pennsylvania. This was the beginning of a long professional relationship between Adelphia Cable and Jerrold Electronics, now a division of General Instrument.

A small operation in the beginning, Adelphia's staff consisted of John Rigas, one technician and one office person per system. In the early days, the home office of Adelphia was a desk in the hallway of the law office of one of Rigas's partners in Coudersport.

During the early 1960's, Adelphia grew rapidly, acquiring new franchises in Punxsutawney, Reynoldsville, Sykesville, and Uniontown, all communities in Pennsylvania. By 1962, Rigas had left his position at Air Preheater and was spending all of his time and energy in expanding his cable business. Naturally, the office staff grew with the addition of subsequent cable systems.

It was in the mid-l960's that Rigas sold two of his systems, a one-time-only occurrence in Rigas's successful cable television career. In 1966, he sold the Wellsville system, and, in l968, he sold the Uniontown system. In addition, during the late 1960's, Rigas worked with William Pallas to construct and operate cable systems in Tennessee. This new growth represented nearly 10,000 new cable customers for the company.

The organization was officially incorporated in 1972 as Adelphia Communications Corporation, with John Rigas and Gus Rigas becoming the largest shareholders. John led the company through continued growth during the rest of the decade. By the late 1970's, Adelphia had grown to 24,000 subscribers.

Adelphia weathered the difficult period of the early 1970's, which saw growth restrictions placed upon the cable television industry by the Federal Communications Commission (FCC). Other cable restrictions included limitations of programming on pay networks and the mandate that cable operators carry local broadcast signals upon request. Adelphia overcame the challenges, however, and, by the late 1970's, the company was positioned for more important growth. Rigas moved the headquarters to a suite of four rooms above a hardware store on Coudersport's Main Street, and the staff increased accordingly. In 1981, the company moved again to an old church in Coudersport, where corporate headquarters are still located.

Adelphia Communications Corporation continued its impressive growth through the 1980's and is now the eighth largest cable television multiple system operator (MSO) in the United States. Adelphia, meaning "brothers" in Greek, now has operations in 11 states, including New York, Pennsylvania, New Jersey, Vermont, Virginia, Massachusetts, Michigan, Ohio, North Carolina, South Carolina and Florida. Its total subscriber base is more than l.3 million, and it has a total of more than 2,400 full-time employees.

An active member of the cable television industry, Rigas was a member of the Board of Directors of the Pennsylvania Cable Television Association Board (PCTA) in the late 1960's and served a two-year term as President from 1968 to 1969. He is currently serving a third term on the Board of Directors of the National Cable Television Association (NCTA) and is a member of the Cable TV Pioneers clubs of both the NCTA and PCTA. In addition, he sits on the Boards of Directors of C-SPAN and the Cable Advertising Board (CAB). He is a member of the Regulatory Committee for Cable Telco and the Entrepreneur's Group as well as a nominee for the Katz Graduate School of Business Board of Visitors affiliated with the University of Pittsburgh. He is a 1995 inductee into *Broadcasting and Cable* magazine's Hall of Fame.

In addition, Rigas is an active community leader, serving on a number of boards for both private and non-profit groups. These include the Board of Directors of Citizens Trust Company in Coudersport; trustee for St. Bonaventure University in Olean, New York; Chairman of the Board for 13 of his 22-year tenure as Director of Charles Cole Memorial Hospital in Coudersport; and Former Trustee of Mansfield University. He is former President of the Coudersport Rotary Club, having been an active member for more than 40 years and is also active in the Coudersport Chapter of the American Legion.

An avid sports fan, Rigas currently is negotiating to purchase the Pittsburgh Pirates baseball organization, and, in 1994, the company acquired 34 percent equity interest in Niagara Frontier Hockey, the organization which owns the Buffalo Sabres National Hockey League franchise. The Sabres partnership will control the Crossroads Arena, a new sports and entertainment facility currently being built in Buffalo, with expected completion in 1996. Adelphia also has controlling interest in the Empire Sports Network, which will distribute the Buffalo Sabres hockey games. In addition, the company has also formed Hyperion Telecommunications Systems, Inc., which offers alternate access telecommunications services, providing business customers a less expensive alternative for connecting to long-distance telephone service carriers.

John Rigas and his wife, Doris, live in Coudersport, a small community of 3,000 residents situated in the Allegheny Mountains. They have four grown children who are each involved in some aspect of Adelphia Communications Corporation.

u contributed by Valerie Switzer

Aiken, Howard Hathaway (1900 – 1973)

American mathematician and inventor of the country's first programmable computer, the Harvard Mark I — the forerunner of the modern electronic digital computer.

Aiken was born in Hoboken, New Jersey, in 1900 and was educated at the University of Wisconsin, Madison, and Harvard University. After receiving his doctorate in engineering from Harvard in 1939, he taught there for a short time before joining the war effort as a commander in the U.S. Navy Board of Ordnance. That year, the Navy allowed Aiken to lead a team of Harvard and IBM scientists on a project to create an automatic calculating machine with potential across a wide range of military applications.

The proposed machine's purpose was to perform any selected sequence of five arithmetical operations without human intervention. These included addition, subtraction, multiplication, division and reference to previous results. IBM sponsored the project financially, foreseeing the machine's potential value. Harvard involved its scientists, hoping for a device that could perform scientific calculations.

Aiken's team, which included noted programmer Grace Murray Hopper, worked for five years, and in early 1944 they successfully completed the IBM Automatic Sequence Controlled Calculator, commonly known as the Mark I. It used punched paper tape for programming and vacuum tubes to calculate problems. Approximately 50 feet long and 8 feet high, the Mark I weighed 35 tons. The Navy utilized it for gunnery, ballistics and design problems.

Not content with his first effort, Aiken introduced an improved, all-electric Mark II in 1947. Over the years he also wrote many scholarly articles on electronics, data processing, and switching theory. For Aiken's significant contributions, he was honored by France, Belgium, Germany, The Netherlands and the United States. Howard Aiken died in 1973 in St. Louis, a pioneer in the field of computing.

u contributed by Kay Volkema

Ameritech Corporation

The regional Bell operating company (RBOC) — also known as a Baby Bell — that provides the Great Lakes region with local telephone, cellular and Yellow Pages services, and is expanding into other consumer information services.

In 1984, American Telephone & Telegraph (AT&T) spun off its local operating subsidiaries as part of an antitrust settlement with the U.S. government. Regional Bell operating company (RBOC) Ameritech received five of AT&T's 22 telephone subsidiaries, a cellular service provider and directory publishing. The company shares Bell Communications Research (Bellcore) with the other six RBOCs . Organized into customer-focused business units, Ameritech serves over 12 million customers in Illinois, Indiana, Michigan, Ohio, and Wisconsin. Ameritech CEO Richard Notebaert is dedicated to transforming Ameritech from a telephone company into a full-service communication provider. The company is streamlining operations, seeking regulatory approval to expand into long distance and preparing for a future that will include video, interactive and wireless services.

To expand its service base, Ameritech joined with another cellular provider in 1992. Although it remains one of the smallest RBOCs (also known as Baby Bells) in the field, Ameritech's cellular operations grew 48% in 1993 alone. In partnership with Bell Canada, Ameritech started an electronic mail and information services company that now serves one half million customers. Ameritech also has invested in two voice messaging and audiotext services companies.

A comprehensive Ameritech plan filed with the Federal Communications Commission (FCC) could introduce a new era in American telecommunications. Ameritech's *Customers First* plan proposes that Ameritech open its local communications network to full competition and, in exchange, gain the right to offer long-distance services to its customers. While local telephone services (including access fees paid by long-distance companies) represent nearly 95% of its profits, Ameritech projects future growth will come primarily from interactive and wireless communications services, and through other suppliers using its network. Another opportunity lies in regional long-distance (calls beginning and completed in its own region), a business estimated at $3.5 billion annually.

A 1994 change made by Ohio regulators — sought by Ameritech — involves profitability caps. These long-standing restrictions have made rate increases and equipment installations the only viable ways to increase returns, and have provided limited incentive to operate more efficiently. Ameritech's regulators now have removed earning caps while Ameritech will cap prices to local telephone customers. And, Ameritech may depreciate antiquated equipment more quickly, replacing it with advanced technology to increase efficiency and product offerings.

In 1993, Ameritech invested $472 million in a venture with General Electric to link retail, finance and transportation companies with their customers and suppliers. Because the plan conflicts with federal rules prohibiting Baby Bells from transmitting across their boundaries, the investment is currently structured as a loan as Ameritech continues to pursue governmental approval to offer long-distance services. If long distance restrictions are changed within four years, Ameritech's investment becomes a 30% share in the new company.

In January 1994, Ameritech announced plans to invest more than $4 billion to expand its capacity to offer interactive services to homes, businesses, schools, and hospitals. While Ameritech's primary mission is to go beyond entertainment to education, health and government services, it believes short-term acceptance depends on quality entertainment programming. Consequently, Ameritech has joined with Walt Disney and RBOCs BellSouth and SBC Communications, Inc. (formerly Southwestern Bell) to initiate a joint venture to develop and deliver such programming.

In its education, health and government services sector, the company has launched pioneering efforts in several states. The Warren, Michigan, ThinkLink service links home and school for 125 fifth-graders so they can do homework using video and individualized access to educational programs. Another Ameritech joint venture enables selected Wisconsin health care providers to electronically transmit patient information. SkillLink, an Ohio interactive distance learning project, provides workers with skill refreshers and retraining.

An Ameritech joint venture with British Columbia Services Corp. will develop services to eventually enable computer users to access governments' computerized information ranging from drivers' licenses to property records. The new services are being modeled after a British Columbia Systems' software program used successfully in Canada to access local real estate listings.

Internationally, Ameritech is a major shareholder (along with Bell Atlantic) in New Zealand's principal telecommunications supplier. It also provides cellular services in Poland and Norway, and owns 30% of Hungary's telephone company, Malav. Ameritech continues to explore opportunities in communications in the Asia-Pacific region, Europe and Latin America.

u contributed by Susan P. Sanders

Notebaert, Richard C. (1948 -   )

American business executive, currently Chairman and Chief Executive Officer of Ameritech, a regional Bell operating company (RBOC).

Richard C. Notebaert began his career with the Bell system in 1969 at Wisconsin Bell. From that beginning, Notebaert's career included working experience in numerous aspects of the telecommunications business before being named Chairman and Chief Executive Officer of Ameritech in mid-1994.

Notebaert received his undergraduate degree in 1969, as well as his MBA in 1983, from the University of Wisconsin. During his early career at Wisconsin Bell, he held increasingly responsible positions in marketing and operations. In 1983, Notebaert became Vice President of Marketing and Operations at Ameritech Communications, and President of Ameritech Mobile Communications in 1986. After serving as President of Indiana Bell from 1989 to 1992, Notebaert became President of Ameritech Services. He was named Ameritech Vice Chairman in 1993 and assumed his current position in 1994.

The story of Notebaert's selection to ascend to Ameritech's top position is a part of American business folklore. In 1992, Ameritech's then-CEO William Weiss (the last of the original Baby Bell CEOs named when AT&T was broken up in 1984) called a meeting of his top executives. He asked each to write a profile of their vision of Ameritech in 1995. As the story goes, only four shared Weiss's enthusiasm for competition in long distance, along with video and wireless services, and remained around the table to guide Ameritech. Richard C. Notebaert was one of them. He was later hand-picked by Weiss to succeed him.

Notebaert, known as an analytical and results-oriented leader, has received honorary degrees including an Honorary Doctor of Business Management from Indiana Wesleyan University, Honorary Doctor of Science and Technology from the University of Indianapolis, and Honorary Doctor of Science from Ripon College. He was appointed by President Clinton to the President's Export Council in 1995. He is a member of the Chicago Council on Foreign Relations, the Business Roundtable, the Committee for Economic Development and the Council on Competitiveness. Notebaert is also a trustee of the Chicago Symphony Orchestra and Northwestern University.

u contributed by Susan P. Sanders

Amplifiers

Analog devices that increase the strength of an electronic signal.

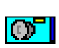
When an electronic signal is transmitted, it has power or strength, called *amplitude*. As the signal travels from its point of origin, it loses its strength, a process called *attenuation*. When a signal must be sent to a distant receiver, amplifiers are used along the way to boost the amplitude, and are installed in the receiver to increase the amplitude to an acceptable level. Signals that are sent along a wire or cable, called *transmission mediums*, are attenuated by resistance in the wire or cable as the signals go from the transmitter to the receiver. For telephone, cable television and computers, the wire or cable is normally made of copper. For wireless services, such as cellular telephones, satellite communications and broadcast television, the signal loses strength as it travels through the earth's atmosphere, even though the signal does not use the atmosphere as a transmission medium. Wireless signals are amplified at the receiver. Satellite signals are amplified at the satellite and at the receiving site.

Amplifiers increase the strength of whatever goes into them, whether it's the signal or any interference, called *noise*, that the signal has picked up from other electrical sources along the way. In addition to amplifying the signal and the noise, the electronics of the amplifier also add a small amount of noise to the signal. If an electronic signal were amplified over and over, eventually there would be so much noise that it would block out the signal. When this happens, the *signal-to-noise ratio* is so low that the sound can't be heard or the picture can't be seen. When several amplifiers are used between the source and the receiver, it is called a *cascade* of amplifiers.

A low ratio of signal-to-noise is partly created by the accumulated noise that comes from the cascade of amplifiers, getting worse with each amplifier until the sound has static or the picture appears to be grainy. Since the ratio of power is between a desirable element (signal) and an undesirable element (noise), a high signal-to-noise ratio is good. For example, a signal-to-noise of 47 is better than a signal-to-noise of 40. The power relationship between signal strength and noise, a ratio of power, is measured in *decibels* (dB).

The challenge for engineers who design communication systems and networks is to deliver a signal with very little noise, but also to make sure that the signal has enough amplitude to be usable.

Cable Television Amplifiers
A cable television radio frequency (RF) signal, which includes many channels at different frequencies, is delivered to the customer through a distribution network comprised of trunk cable, feeder cable and a customer drop cable. Although each of these cables can have amplifiers on them, typically amplifiers are only used on the trunk and feeder cables, since they carry the signal greater distances than the drop cable.

A *trunk amplifier*  is positioned at intervals along the trunk cable to maintain the signal strength as the RF signal moves away from the origination point, called the headend. Each trunk amplifier receives the signal, which is made up of one frequency for each channel. Since the attenuation of each frequency is different, the amplifier adjusts each frequency, amplifies each one, then reinserts the signal into the trunk cable.

The trunk cable carries both RF and alternating current (AC) power that have to be separated before the RF signal can be amplified. Some of the AC power is filtered off and passed through to the trunk cable that exits the amplifier. Some of the AC power is converted to direct current (DC) power and is used to operate the amplifier. Powered amplifiers are said to be active, while unpowered devices in the cable system, such as splitters, are said to be passive.

The RF signals that enter the trunk amplifier do not all have the same amplitude. Although they have all been attenuated by the cable they passed through, the higher frequencies are attenuated more than the lower frequencies.

For the amplifier to be effective, all of the frequencies entering it must have the same amplitude. An attenuator called a *pad* is used in the amplifier to make sure that the signals coming in are within the amplifier's adjustment range. The signal then goes through an *equalizer* that attenuates the lower frequencies more than the higher frequencies. Since the higher frequencies have been attenuated more than the lower frequencies, the equalizer makes sure that all of the signal levels are the same before they are amplified.

The Amplification Process

The signal goes through two stages of amplification: the *preamplifier* is the first stage and the *postamplifier* is the second. If an amplifier had one stage, it would have to increase the signal all in one step. Too much amplification at one time, however, can cause the signal to be distorted, resulting in odd sounds and pictures. In a two-stage amplifier, the preamplifier receives signals of a low level and amplifies them with a minimal increase in noise or distortion. The amount that a signal is amplified is called *gain*. The output of the preamplifier is a signal with high gain and low noise.

Between the preamplifier and the postamplifier is the interstage circuitry. This circuitry can be tuned manually or automatically. It controls the gain and the relative levels of the output frequencies, called *slope*. The automatic gain control (AGC) reads the level of a specific high frequency channel, called the *high pilot*, and makes adjustments based upon that level. The automatic slope control (ASC) reads the *low pilot* and uses it to maintain a constant relationship between the amplitude of the highest and lowest frequencies.

The postamplifier is the second stage of amplification and the final one before the signal is reinserted into the trunk cable. The postamplifier is a high-gain, low-distortion amplifier that increases the amplitude of the signal from the preamplifier.

The output of the amplification process is a signal in which all frequencies are stronger, but the higher frequencies have a higher amplitude than the lower frequencies. This sloped output is produced because, as the signals move to the next amplifier, the strength of the higher frequencies will be attenuated more than the strength of the lower frequencies. The signal is then reinserted into the trunk cable, along with the AC power that was filtered off.

The trunk amplifier can also have another amplifying function. It can amplify the narrow band of low-frequency return signals that are transmitted from customers back to the headend.

Whenever the signal on the trunk cable is split so it can go onto a feeder cable, a trunk amplifier is used. A *bridger* is an active device that splits the signal and connects, or bridges, it to the feeder. The signal to be split first goes through a trunk amplifier, then the output goes to the bridger. The bridger is enclosed in the same housing as the trunk amplifier, and the combination is referred to as a *trunk station*.

Amplifiers on the Feeder

The feeder cable begins at the bridger and provides service to a neighborhood or group of houses. Although the RF signals do not normally travel as far in the feeder cable as they did in the trunk cable, feeder cable has a smaller diameter than trunk cable and causes more attenuation per foot of distance. A *line extender* (LE) is the amplifier that is installed along the feeder cable.

LEs maintain an acceptable signal strength in the feeder. In the LE, the AC power is converted to DC power to operate the line extender, and if there are other LEs farther along the feeder, AC power is also passed through to power them.

Like the trunk amplifier, the LE includes an attenuator, equalizer and amplifier. The line extender may also have automatic gain and slope controls that maintain the signal within preset ranges. The LE can also amplify a return signal from the customer back to the headend.

Amplifier Configurations

Trunk amplifiers, including those used in bridgers, and LEs come in three different configurations: push-pull, parallel-hybrid and feedforward.

The *push-pull* configuration consists of two single-ended amplifiers. One amplifies on only the positive part of the AC power cycle and the other amplifies only on the negative part of the cycle. The push-pull configuration reduces distortion significantly, is more efficient than a single-ended amplifier, and is typically used in cascades of up to 20 devices.

A *parallel-hybrid* configuration consists of two push-pull amplifiers. Each of the stages amplifies half of the signal input power, then the signal is recombined for a single output signal. The parallel-hybrid configuration produces even less distortion than the push-pull configuration, allows higher signal levels, and can be used in longer cascades than the push-pull.

The *feedforward* configuration consists of two push-pull stages: one a preamplifier and the other a postamplifier. This configuration produces an inverted replica of the distortion that is created by the amplifier, then combines the two, which cancels out the distortion. The feedforward configuration reduces distortion and noise, allows the highest signal levels of the three configurations, and can be used in cascades of 35.

Telephone Amplifiers

Most long-distance telephone circuits are digital and are transmitted on fiber-optic cable, where, because digital signals go through repeaters and regenerators, analog amplifiers are not used. Amplifiers are used, however, on local-loop analog telephone circuits, both two-wire circuits (one twisted pair) and four-wire circuits (two twisted pair), when distances require them. For example, suppose a customer has an off-premises extension. An incoming call first goes to the main telephone, then to the extension. The extra distance the call travels may require the use of an amplifier to maintain the signal strength.

Two types of telephone amplifiers in use are *negative impedance* and *switch gain.* The negative impedance type amplifies the signal in both directions. The switch gain amplifier only amplifies the signal in one direction at a time; for example, when a speaker phone is used and only one party can be heard at a time.

An *optical amplifier* is a newer device that amplifies an optical signal without first converting it to an electrical signal. One type amplifies with a laser pump diode and a section of erbium-doped fiber, and another type of optical amplifier uses a semi-conductor laser.

Other Amplifiers
In other analog applications, the voltage is amplified with an *operational amplifier*. It is comprised of an integrated circuit that allows the voltage to be controlled very precisely. To do this, a resistor is connected to the output of the circuit and negative feedback is applied to the output. The gain of the operational amplifier is expressed as a ratio of the feedback resistance to the input resistance.

Satellite Amplifiers
The signal amplifier used on communication satellites is called a *traveling wave tube* (TWT). A TWT amplifier is a vacuum tube that has a gain of up to 10 million and an efficiency of up to 50 percent, adding very little noise. TWTs are used to amplify a radio frequency, high-energy signal to a much higher level. A TWT converts the kinetic energy (energy from motion) of an electron beam into microwave energy. It consists of an electron gun, a helix, a collector, and an electromagnet. The signal to be amplified enters the TWT and is guided by the helix in a spiral path around the high-energy electron beam. Because the signal's path is a spiral, it travels farther than the electron beam and the beam moves through the TWT faster. The electrons in the beam bunch up and create a strong electromagnetic field that transfers the kinetic energy of the electrons to the signal. A long helix amplifies the signal more than a short helix.

When the signal reaches the end of the helix, it is transferred to a waveguide that is the output for the amplified signal. The collector absorbs any energy from the electron beam that is not transferred to the signal. The electromagnet contains the electron beam, prevents it from spreading, and guides it through the helix.

Since it is a vacuum tube, a TWT amplifier generates a great deal of heat during operation. Also, a TWT consumes a large amount of energy compared to the other satellite components, which are all solid-state (transistorized). For these reasons, solid-state signal amplifiers that use gallium arsenide (GaAs) chips are being developed to replace TWT amplifiers.

When the signal from a satellite is received by an earth station on the ground, its strength can be as low as 4 trillionths of the signal that was transmitted by the satellite. The signal is so low that before it can be transported from the antenna to the receiver, it has to be amplified. A *low-noise amplifier* (LNA), located on the feed horn that sticks out from the center of the antenna, amplifies the signal as it is received. The LNA amplifies very low energy signals to higher levels and is normally a parametric amplifier, which increases the strength of one individual frequency.

u contributed by Paul Stranahan

Analog/Digital Communications

There are two ways to communicate information over the airwaves or electronically — analog and digital. In analog transmission, which was the only common method used until fairly recently, a continuous electrical or radio frequency wave is transmitted. In contrast, digital transmissions are created by transmitting a code (often binary) that represents specific and finite elements of sound, data or video. Digital transmission has opened up a whole new realm of possibilities in all aspects of telecommunications.

Analog Transmissions
For voice to be sent over wires (as in a typical telephone system) the sound is converted into a continuous electrical signal that varies in strength (amplitude) or tone (frequency). This continuous electrical signal is an analog transmission.

For sound or pictures to be sent over wires or broadcast over the air (as in radio or broadcast and cable television) the sound and/or picture are converted into electrical signals that modulate, or change, a radio frequency called a carrier wave. The receiver then demodulates the signal by removing the carrier wave, leaving only the sound and/or picture signal. Since the radio frequencies are continuous waves, they, too, are analog signals that again vary in amplitude and frequency.

For transmissions of signals over short distances, analog works very well. However, when signals are sent over longer distances, the analog waves begin to distort and lose strength. Amplifiers were developed that could boost the strength of the signal, but unfortunately the amplifiers also boosted any noise or undesirable signals that were on the line. Noise could come from any number of sources, such as lightning strikes, power grids, other electrical signals, radio or television broadcasts and poor connections. As the signal strength was boosted, so was the noise level. For voice transmissions over analog telephone lines, the distortion and noise levels were manageable and most people never noticed them.

Digital Transmissions
But then along came computers and the need to transmit digital data. Distortions and noise on analog lines transmitting computer data could cause significant problems at the receiving end; so in the early 1960's, digital transmission was created. In a digital system, data (which is often in a binary format) or sample information about the sound wave is sent. In one common method, the original analog signal (for example, a voice) is sampled several thousand times per second, and values that represent the signal's amplitude are translated into a series of 8-bit binary codes. A binary code consists of data in one of two states, a one or a zero (on or off). All voice, picture, instrumentation and other analog signals can be coded in binary form. These binary signals form binary digits, or bits. This digital data can then be grouped to form message packets, which are discrete groups of bits that are kept together to aid transmission. In addition to data, each packet includes a coded address (the destination), its sequence (where it fits within a long message) and sometimes error detection (a simple method to identify packets which contain transmission errors).

Digital transmission uses regenerator/repeaters rather than amplifiers. The regenerator/repeater performs two functions: it retimes the bits in the data stream and regenerates the original data waveform, removing any noise or time lags or shifts in the data. Because the regenerator only needs to determine whether a signal level is a one or a zero, it's relatively easy to recreate the original voltage level, signal and timing. The repeater then reproduces the signal and sends it on in its original form. In this way, digital signals can travel great distances, through several regenerator/repeater nodes, without significantly degrading or collecting errors. Therefore, digital conversion and transmission of analog signals, like voice, reduces system noise and improves communication quality. For high-speed data, digital transmission is absolutely essential. In addition, digital information can be compressed to decrease the amount of data to be transmitted and, therefore, the time required to transmit.

Analog to Digital Conversion

The original use of telephone lines to transmit data between computers required the digital data to be translated to analog signals to flow across analog telephone wires, then be translated back to digital so it could be understood by the receiving computer. When digital technologies initially emerged, it was believed that all networks would be changed to digital. But for the telephone companies, this would have involved billions of dollars in capital investment and years spent rewiring their systems. At first, improved technology for analog switches and amplifiers made it more profitable for telephone companies to upgrade their analog networks, while at the same time putting in digital capabilities where the cost and application (such as computer-to-computer communication) justified it. Today, most of the U.S. public switched telephone network (PSTN) uses digital technology, and the only segments of the PSTN that are still analog are the connections between the central offices and the residential or business telephones. Someday, these too will be converted to digital; however, millions of analog telephones will become obsolete in the process. In most parts of the world, new telephone circuitry uses digital technology.

Using Digital Technology

Examples of the use of digital technology in formerly analog environments are becoming more common. Historically, sound was transmitted and preserved in analog form as, for example, on phonograph records. Now, these records are being replaced by compact discs, which are a form of digital storage media that have all the benefits of digital transmission and higher immunity to physical damage. In the modern telephone system, numerous conversations can now be translated to digital form; bundled together using different time frames; transmitted by wire, optical fiber or over the air; and then unpacked to be sent to individual receivers. The image from a television camera can be broken up into small dots, called pixels. The brightness and color of each pixel can be assigned values that are represented by digital codes. These binary numbers are then transmitted to a receiving station and reformed as the original picture.

The most modern switching devices in use today by the telephone companies are the digital stored-program switches. Analog signals coming in from a telephone are converted into digital signals, then sent into what is, in essence, a large, single-purpose computer. The digital-switching circuitry then finds the shortest and least loaded route to connect the incoming call to an outgoing line. In addition, advances in transmission systems have made it possible to integrate different types of signals, whether voice, data or image, on the same digital carrier. At the receiving end, the signals are then separated and converted back to their original form. (See asynchronous transfer mode below.)

Digital Video

But transmitting and switching digital sound and data is one thing; video is quite another. In an analog world, one of the major concerns is the *bandwidth* of the transmission media that is being used to carry the signal. The greater the bandwidth, the more information that can be carried. In the digital world, the *transmission rate* is what determines how much information can be sent. An ordinary twisted-pair telephone wire has a transmission rate of approximately one million to 10 million bits per second (bps) over short distances, but a full-motion television picture (30 frames per second) requires 10 million to 100 million bps. In addition, a switch or connector must be able to pass data at that high rate to allow video to be carried over telephone lines. One newer method of switching voice, data and video on the same line is called asynchronous transfer mode (ATM). In ATM, each signal is digitized, then chopped into packets of information called cells. The cells travel together and are opened up and sorted out when they reach their destinations.

Digital Cellular Communications

Digital transmission is also being used in cellular communications. The use of digital signals increases the capacity up to 15 times that of analog systems. In addition, digital transmission virtually eliminates the three major problems encountered by analog cellular users: static, loss or interruption of signal when passing between antennas and failure to get a connection because of congested relays. However, some users feel that the digital conversion leads to unsatisfactory reproduction of voice quality.

Integrated Services Digital Networks

For the telephone companies, and perhaps the television industry also, the future of digital technology may center around Integrated Services Digital Networks (ISDNs). ISDN is an end-to-end digital transmission system. In an ISDN network, voice, data and video signals are immediately converted to digital signals at the transmitting end. Although the technology has been around for a number of years, it was originally thought that fiber-optic cables were required to make it work. The construction of nation-wide fiber-optic-based networks was considered too costly an undertaking and was basically shelved for a number of years. Plus, improvements in data compression technology mean that it may well be possible to use much of the existing copper wire that forms the telephone companies' local loops to send much more data than anyone ever imagined. Today, the interest in ISDN as a viable technology for the telephone companies has been rekindled, and ISDN is now seen as a way to send and receive full-motion video, high-speed Internet data and other broadband services over copper wire.

Although analog and digital transmissions are both still widely used, future advancements in technology will eventually lead to totally digital networks capable of handling a mixture of voice, data and video transmissions. It will take a number of years, but eventually analog devices, like a standard telephone, will be replaced by digital devices that change voice, data and video into digital signals directly at the source.

u contributed by Linda Stranahan

Authoring Systems

Originally developed to assist educational software design, authoring systems today also include programs used to create multimedia presentations. They often include predesigned formats and menu options that can greatly reduce the need for software engineering.

Authoring systems are special purpose software programs that can be used to create interactive programs, instructional software, and multimedia presentations. They use specially designed programming languages, called authoring languages, to combine a number of elements, including video, graphics, text, sound, and animation into a cohesive package.

The development of authoring systems began with advances that were made in programming languages in the 1960's. It was then that computer programmers developed new languages that allowed computers to both accept and process information while running. Until then, computers used programs that ran in batch mode, which restricted information output until the program finished running.

The interactive nature of these new programs allowed two-way communications between users and computers, making them ideal components for educational software that could both record and analyze student answers. By the 1970's, these new languages, now known as authoring languages, were made available to educators for program design.

Authoring languages were also used to create authoring systems, which were first introduced in the late 1970's. These systems--also known as program generators--offered a number of benefits, including predefined fields and options that could be selected and combined in a multitude of ways. Their structured nature also largely eliminated programming errors, making it easier for educators without programming knowledge to design interactive software programs for their classrooms.

As computers increasingly became able to support multimedia elements such as graphics, color, and animation, more sophisticated authoring systems were developed to enable the inclusion of these elements in interactive programs. The popularity of graphics-based, interactive computer programs has made authoring systems important tools for software development in other areas besides education.

A wide variety of authoring systems are available today. They run the gamut from presentation programs that combine slide shows with text, images, sound and animation, to interactive authoring systems that use on-screen buttons, or hot-spots, that allow users to seamlessly jump from one topic to another.

u contributed by Sonia Weiss

Analytical Engine

First conceptualized in 1835 by English mathematician and inventor Charles Babbage, the steam-powered analytical engine was the first general-purpose computer ever conceived. It outlined many components of modern-day computers.

After trying to build a differential calculator for 10 years with limited success, Charles Babbage had an inspiration. Instead of building a mechanical computing machine that was only able to execute differential equations, he would build one that could solve any mathematical problem. His Analytical Engine would be steam powered, fully programmable and able to perform an array of applications. The engine's basic design contained memory, called a "store," which could hold 1,000 numbers of up to 50 decimal places long and a "mill" that processed and coordinated the numerical operations.

The parent of the modern computer's central processing unit (CPU), the mill could perform instructions and calculations in any sequence. The machine borrowed the concept of punch cards for programming from the Jacquard loom. Programmers would punch these cards in a sequence that controlled the machine's operations. Babbage also designed output devices for his machine to print written results, 50 years before typesetting machines were invented.

The Analytical Engine would have stood 15 feet tall, its mill would have been 6 feet in diameter and its store would have been 15 to 20 feet long. Due to continuing financial problems, design flaws, labor disputes and personal tragedies, however, Babbage died without seeing his plans realized. In 1906, his son persuaded an engineering firm to construct a smaller-scale version of the machine from Babbage's original drawings just to see if it would in fact work. It did, calculating the first 25 multiples of . Today that machine resides in the London Science Museum.

u contributed by Christopher LaMorte

Antennas

Antennas are devices that transmit and receive electromagnetic signals, which are used to carry television and radio broadcasts, microwave and cellular telephone calls, as well as other signals like radar.

If you look closely at an insect, you will see two thin appendages protruding from the top of its head. These appendages are the creature's sensory organs and let it communicate with its fellow insects and with the outside world by collecting and distributing information. When human beings began to transmit signals electronically, they too used antennae. In fact, these man-made communication devices frequently looked similar to the insect variety, though on a much larger scale.

Often constructed on large towers, an antenna can be either a transmission point or a receiving point for radio communications, though generally not both at the same time. Television, radio, cellular phones and satellites all use radio waves to carry their signals. A transmitting antenna takes electrical signals and converts them into electromagnetic energy (commonly called radio waves). The electrical signals it converts may be sounds, pictures or other types of information. The radio waves carry this information and distribute it over a specific area. The range of the area differs depending upon the strength and size of the antenna. Some antennas, such as those serving a high school radio station, may have a range of a few miles. Others, such as those used for satellite communication, may beam their signals several thousands of miles into or from outer space. As these waves come in contact with a receiving antenna, they are converted from radio waves into electrical energy.

Off-air antennas are used to receive signals that are broadcast through the air for distribution to a general audience. For instance, local television and radio stations broadcast their signals to a metropolitan area and any radio or television can receive them. That is because these devices come with or are attached to off-air antennas. Before cable television became widely popular, most viewers had off-air antennas on their rooftops, or a smaller version (commonly known as "rabbit ears") on the top of their TV sets. Cable systems have large off-air antennas that capture these local signals, which are then converted back into electrical signals and sent through coaxial cable to cable television subscribers. This eliminates the need for those who receive cable TV to have off-air antennas on or in their houses.

Because the air is filled with electromagnetic radiation fields of various frequencies at any given time, receiving devices like radios or televisions must be tuned to a particular frequency in order to receive only the frequency desired.

Cable systems also have earth station antennas for receiving radio signals that are distributed via satellite by other earth station antennas. Unlike off-air antennas, signals distributed by satellite can cover wide geographical areas. National broadcast television networks (ABC, NBC, CBS, and Fox) use satellite transmissions to distribute their programming to local affiliates, which have earth station antennas to receive the nationally distributed signals. The local affiliate then broadcasts the signal to its viewing area using a broadcast tower that propagates signals within a frequency range that off-air television antennas can receive.

Some viewers, particularly those in isolated or rural areas, have earth station antennas known as television receive only (TVRO) dishes that are used to receive satellite signals. Another option is direct broadcast satellite (DBS), a subscription television service like cable. DBS, however, uses small satellite dishes about 18 inches in diameter to receive cable-type programming. Because DBS is distributed directly to customers via satellite, it does not include local off-air television programming like cable television does.

Microwave antennas are used for point-to-point radio distribution such as links between telephone networks. These antennas look much like satellite dishes in that they have a parabolic shape. Microwave antennas are also used to receive reflected radar signals and for space investigation. For instance, astronomers use very large antennas with diameters of 1,000 feet to receive radio signals floating in outer space to study distant planets and stars.

u contributed by Christopher LaMorte

Off-air Antenna

Usually constructed of metal, an off-air antenna receives television and radio signals broadcast to a general audience.

Anyone who owns a portable radio or TV is familiar with an off-air antenna. These are the “rabbit ears” that stick out from the back of the set. One periodically needs to adjust this antenna to pick up stations more clearly. Off-air antennas like these are designed to receive radio signals within certain frequencies that have been broadcast by local radio or television stations. The radio signals are then converted into electrical signals and amplified by the radio or television set. Besides the familiar “rabbit ears,” there are two other types of off-air antennas that work in the same fashion. One is designed to be mounted on top of a home, and another type is used by cable television providers to send local television signals to subscribers.

Before cable television became widespread, many homes had off-air antennas stationed atop their roofs. By wiring a television set to this antenna, a person could improve the television reception. FM stereos could also be wired to the rooftop antenna to increase the range of the FM receiver and the signal quality.

About 60 million American homes now receive broadcast channels, like ABC, CBS, NBC and FOX, through their cable provider. That is because cable providers have large off-air antennas to pick up regular TV broadcasts and send them to their customers as part of their basic subscription package. In fact, the original purpose of cable television was to provide over-the-air broadcasts to areas where mountainous terrain created poor reception. The off-air antennas that cable systems use are more elaborate affairs than the ones found on rooftops. A cable system’s off-air antenna usually has many antennas, each tuned to a particular frequency range. Cable providers combine these off-air signals with those that come from satellite reception, which ordinary homes do not receive. This gives cable subscribers a greater selection of channels from which to choose.

u contributed by Christopher LaMorte

Apple Computer, Inc.

One of the leading personal computer manufacturers in the United States. Also produces computer-related hardware and software. Headquartered in Cupertino, California, Apple is considered one of today's preeminent computer companies.

In April 1976, two Californians in their twenties founded Apple Computer to help market their preassembled computer circuit board. Steven Jobs and Stephen Wozniak met (while Jobs was attending junior high school and Wozniak high school) in the Silicon Valley. Sharing an interest in electronics, their paths crossed a number of times over the next few years. While Wozniak was working for Hewlett-Packard and Jobs was working intermittently for Atari, they became active in the Home-brew Computer Club in Palo Alto, California.

In his spare time, Wozniak was working on an innovative computer circuit board of his own design. Jobs saw the potential in it and convinced his friend to try to sell it to computer hobbyists. So they joined forces and began designing and building the circuit board in earnest in the garage of Jobs's parents, a project they financed by selling personal possessions. Both were electronics buffs, but Wozniak was the technical expert and Jobs the computer visionary. They called their new machine the Apple Computer and sold 600 units at $666.66 each in 1976. Despite its humble beginnings in a garage, the Apple was the genesis of a huge new industry in personal computers (PCs).

Jobs and Wozniak incorporated the company in January 1977, along with Armas Mike Markkula, their new partner and Chairman. A retired electronics engineer who had managed marketing for Intel Corporation and Fairchild Semiconductor, Markkula was highly experienced and well connected in the Silicon Valley. He secured and personally provided investment capital for the new business. He strategically recruited experts from the top technological companies to become Apple's managers and board members.

In 1977, the company successfully launched the Apple II personal computer, the first to be sold in preassembled form and the first commercially successful PC (earning $2.7 million the first year and $200 million by 1980). It was simple, compact, able to generate color graphics, and had eight slots for additional devices and software programs. The next year, Apple moved its headquarters to Cupertino, California.

A true American success story, Apple went public in 1980 and reached annual sales of $1 billion in 1982. The next year, Apple lured John Sculley away from Pepsi-Cola to be the new President and CEO (l-r: Steven Jobs, John Sculley, Stephen Wozniak), and introduced the Lisa, a personal computer with a hand-held mouse for business use. Apple launched the Macintosh PC for general use in 1984; today the Mac has an installation base of over 10 million units. In 1986, the company introduced the Mac Plus and the Laserwriter Printer which helped popularize desktop publishing.

The mid-1980's were turbulent for Apple and founders Wozniak and Jobs left for different reasons. Yet over the next few years, the newly restructured company's net income increased along with its product line under Sculley's leadership. In 1989, Apple introduced the much anticipated portable Macintosh. The next year, the company began marketing a low-end line of Macintosh computers to interest new customers. In 1991, Apple signed an historic deal with rival industry giant IBM creating two joint software ventures, Kaleida to develop multimedia products and Taligent to develop object-oriented operating software. Soon after, Apple rolled out its PowerBook notebook computers, the multimedia software QuickTime, and Quadra Macintosh PCs.

In mid-1993, Apple President Michael Spindler assumed the role of CEO and Sculley that of Chairman (although he has since departed the company). The hand-held Newton, Apple's next introduction, was designed to translate handwriting into typewritten text, among several other functions. Then Apple announced substantial restructuring plans once again. Also in 1993, Apple entered into a partnership with IBM and microchip manufacturer Motorola to develop the PowerPC, which runs both IBM and Macintosh programs.

Apple's latest strategic move includes developing plans to selectively license its operating system to various computer manufacturers to broaden its market share. With competition increasing daily, Apple Computer, Inc. is facing head-on the many challenges of today's information marketplace.

u contributed by Kay S. Volkema

Editor's Notes:
In early 1996, Michael H. Spindler left Apple Computer, Inc. and was succeeded by Gilbert F. Amelio as Chairman and Chief Executive Officer. The shift in power came amid rumors concerning Apple's financial stability and possible negotiations to sell the company. Apple has denied involvement in any merger talks. A. C. "Mike" Markulla will continue to serve as the company's Vice Chairman of the Board.

Artificial Intelligence (AI)

Research, as well as the technology derived from such research, that attempts to simulate human-like intelligence in artificial mechanisms such as computers.

Although scientists have long dreamed of developing machines that could function like human beings, modern research into the complexities of simulating human intelligence began in earnest in the 1950's, spurred primarily by military efforts in this area during World War II.

It was during this time that scientists on both sides of the Atlantic Ocean worked to develop mechanical systems that could help decipher enemy codes and determine the positioning of artillery guns. These efforts were largely based on theories advanced by two mathematicians--Alan Turing, who had earlier written a paper in which he described a theoretical universal computing machine--and Norbert Wiener, who had coined the term cybernetics to describe his observations of human and machine interaction. Their theories would have a direct impact on the future course of artificial intelligence research.

The term artificial intelligence (AI) was coined in 1956 when 10 scientists gathered at Dartmouth College to discuss their research efforts and how those efforts might be combined to develop machines that could think. They started with the idea of developing machines that would not only be programmed to solve problems, but that could also learn how to solve such problems through intuition and insight. These scientists predicted that in 25 years computers would do all the work, leaving humans to pursue leisure interests. The era of the smart machine was believed to be just around the corner.

Early AI research centered on two differing theories on how human intelligence is formed. The first, known as the machine approach, involves attempting to understand and imitate the physical behavior of the brain. Research utilizing this approach incorporated Wiener's earlier work and focused on developing more powerful and useful machines that actually approximated how a brain worked.

An early breakthrough in this research area was based on the discovery of neural networks in the brain. These networks, researchers found, were composed of millions of interconnected cells that took in information from the environment. Research on how neural networks processed information led to the development of the first electronic brain in 1960--the Perceptron. It consisted of a series of photoelectric vacuum tubes that could be taught to recognize letters by varying the sensitivity of the tubes. Although at first the Perceptron was lauded as a breakthrough in data processing, it never lived up to expectations and the ideas behind it were discarded, only to regain popularity in the 1980's when technological advances made it possible to create networks both on computer chips and in computer software.

The second research avenue centered on what is known as the behavioral approach, which attempts to describe the logical processes of the brain based on such aspects of intelligence as language generation, logical reasoning and rule-governed behavior. Using this approach, researchers developed a program in the late 1950's that could prove logical theories. However, it proved to be unsuccessful at solving problems or making decisions based on its knowledge and previous experience.

In the early 1960's, AI researchers began to cross this barrier by developing programs that depended on general rules, known as heuristics, for solving problems, rather than on algorithms, which define explicit instructions. This approach employed a more human trial-and-error approach to finding answers. This led to the development of programs that could solve logic puzzles and break secret codes as well as programs that could play chess or checkers by analyzing all possible actions and choosing the best one. Many experts began to look forward to programs that could solve any problem.

Scientists soon found that they had overestimated the potential of AI while underestimating the power and complexities of the brain. Limited success had been achieved in some areas; however, the idea of developing a machine that encompassed all facets of human problem solving had not become a reality. Programs such as ELIZA, written in the mid-1960's, demonstrated such limitations by showing how difficult it was to program machines to understand language. ELIZA, named after the character in George Bernard Shaw's Pygmalion, could simulate the interaction between therapist and patient by picking up on key words and providing stock answers. However, it was reduced to selecting stock phrases such as please continue, go on, or I see, when it did not find a recognizable key word.

Although by the mid-1960's some AI researchers still maintained that within 20 years machines would be capable of doing any work a human could do, others felt their original goals had remained largely unattained Since efforts to create a machine that could solve all problems had failed, they focused instead on a narrower approach that defined very specific knowledge areas that a computer could be programmed to know about. Programs such as SHRDLU, developed as part of a doctoral thesis by Massachusetts Institute of Technology researcher Terry Winograd, illustrated this approach. SHRDLU knew all about an imaginary set of child's building blocks. When the appropriate commands were typed in, the program could talk about the blocks as well as move them.

SHRDLU was an early example of what is now known as an expert system. In the late 1960's and early 1970's, many AI research efforts were focused in this area, which put artificial intelligence to practical use by applying the rules of human knowledge in specific areas to problem solving in those areas.

Expert systems research proved successful, and in the 1980's elements of these systems began to appear in a number of commercial computer applications. Programs using expert systems were developed in a number of scientific areas, and applications for these systems soon expanded to other areas as well, including medical diagnosis and equipment operations. Today, such systems often incorporate fuzzy logic, which allows computers to adjust what they do according to their surroundings or circumstances.

AI research and development continues today, with efforts focused in five main areas--expert systems, neural networks, natural languages, robotics and perceptive systems. Expert systems, which many people associate most closely with artificial intelligence research, use a knowledge base of human expertise to solve problems in specified areas. Neural networks are electronic devices or software designed to mimic the neurological structure of the brain. They are often used to design programs that analyze patterns or behaviors.

Researchers working in the area of natural languages seek to improve computer capabilities in the areas of recognition and understanding of human speech and writing. Robots that mimic many human functions are being used in areas ranging from industrial assembly to hospital operating rooms. Perceptive systems research focuses on creating sensing devices such as artificial ears and eyes.

A true thinking machine has yet to be developed, but elements of artificial intelligence are rapidly becoming an everyday part of life. However, even the best AI programs are primitive when compared to the capabilities of the human brain. Intelligence has proved more difficult to simulate than researchers imagined.

u contributed by Sonia Weiss

Atari Corporation

American manufacturer of video game systems and personal computers. Headquartered in Sunnyvale, California, Atari is best known for creating and producing the first commercially successful video game, *Pong*, and for eventually starting a home video game revolution and paving the way for general purpose home computers.

Nolan Bushnell first conceived the idea of arcade video games while attending the University of Utah and working summers at an amusement park in the mid-1960's. During this time, he discovered *Space War*, a video game invented in 1962 by two graduates of the Massachusetts Institute of Technology (MIT) and played on college mainframes by intrigued students. He couldn't help but wonder how a game like this could translate to the midway. By the end of the decade, Magnavox had developed the more sophisticated *Odyssey*, a home video game system in which players used television screen overlays, playing cards and score pads, and Bushnell viewed a demonstration of it in 1972.

Nolan Bushnell's original contribution to the computer entertainment field was *Computer Space*, the first arcade-style video game. But players on the midway found the rocket ship versus flying saucer game too complicated, and it was considered a failure. With his meager profits from *Computer Space*, Bushnell and former colleague Ted Dabney founded Atari with $250 each in 1972, and quickly launched a new video arcade game called *Pong*. Unlike its predecessor, *Pong* was a simple paddle game modeled after table tennis. Because it was both a novelty and extremely easy to understand, the game created a national sensation. Tens of thousands of game machines were manufactured by Atari and counterfeiters.

In the following years, Atari developed variations of *Pong* and brand new arcade games designed by such creative engineers as Steve Wozniak, who went on to co-found Apple Computer, Inc. The company launched a home video game division in 1975 and marketed a popular home version of *Pong* through Sears stores. As a result, Atari did $40 million in business in 1976. That year it was purchased by international entertainment conglomerate Warner Communications, with Bushnell staying on as Chairman. Under his direction, Atari produced a programmable system that allowed users to play a variety of games. It was an instant flop when released in 1978, with only half of the 800,000 Atari 2600 game consoles sold. When this product failed, Bushnell left the company.

In 1979, Atari licensed the wildly popular *Space Invaders* game from Midway and manufactured home versions. This precipitated the second rise of Atari, which became the fastest growing company in American history, with revenues reaching $900 million by 1980. By following the formula of licensing popular arcade video games for home use, the company reaped $2 billion in profits and controlled 75 percent of the video game market in 1982.

But by late in the year, the tide had turned for Atari. Aggressive marketing from competing companies with more realistic graphics and more challenging games combined with the public's growing interest in computers that could do more than play games, caused Atari sales to plummet and never recover. This prompted an unsuccessful takeover attempt on Warner Communications by Australian media tycoon Rupert Murdoch. In 1984, Warner sold Atari for $240 million to American Express (AMEX).

Nintendo reinvigorated the home video game market in 1985 with clever games utilizing high-quality graphics that kept players interested for longer periods. By 1989, Nintendo had $3 billion in sales and 20 percent of the toy market. Using optical disc technology, other game manufacturers including arch rival Atari, have challenged Nintendo by incorporating realistic, 3-D graphics and high-quality sound into their games. In addition, Atari has challenged Nintendo in the courts for antitrust violations.

Currently, Atari has expanded into personal computers, while it continues to compete in the multi-million dollar video game industry which it virtually helped create with a simple game called *Pong*.

u contributed by Kay S. Volkema

Editor's Notes:
In February 1996, Atari announced a merger with JTS, a computer disk drive manufacturer from San Jose, CA. The deal, worth $80 million, will make Atari a division of JTS. The division will be run by JTS officers and will operate under the JTS name. Jack Tramiel will become a member of the JTS Board, having served as Chairman of the Atari Board of Directors since 1984. JTS Chairman Jugi Tandon and JTS President and Chief Executive Tom Mitchell will both retain those titles in the new company.

Babbage, Charles (1792 – 1871)

English mathematician and inventor credited with conceiving the first automatic digital computer, forerunner of the modern computer.

Born in England in 1792, Babbage demonstrated his interest in mathematics early in life by founding the Analytical Society in 1812. Its purpose was to introduce European developments into English mathematics. During this time, Babbage also first conceived the idea of mechanically calculating mathematical tables, and later devised a small calculator that could perform certain computations to eight decimal points.

For his contributions, Babbage was elected a fellow of the Royal Society of London, Great Britain's oldest scientific society, in 1816. Five years later, he received the British Astronomical Society's first gold medal for his paper, "Observations on the Application of Machinery to the Computation of Mathematical Tables."

In 1822, Babbage began developing the Difference Engine, a calculator with a 20-decimal capacity. The British government and the Royal Society officially extended their support to the project. The calculator was never completed, however, due to technical complexities, lack of funding, and Babbage's personal difficulties including a number of family deaths.

After abandoning the Difference Engine, Babbage concentrated on creating a general-purpose computer and first developed his principle of the Analytical Engine in the mid-1830's. Now known as the world's first computer, it could be programmed to solve a wide variety of logical and computational problems.

Babbage was aided in developing the Analytical Engine by Lady Ada Lovelace, the only legitimate child of poet Lord Byron. She contributed support and programming ideas, and helped communicate Babbage's breakthrough concepts to the world. But the Analytical Engine was never completed for virtually the same reasons that caused the demise of its predecessor, the Difference Engine.

Charles Babbage taught mathematics at the University of Cambridge from 1828 to 1839. He also designed a type of speedometer, the first reliable actuarial tables, the cowcatcher (a frame on a locomotive's front that tosses obstacles off the tracks), and he assisted in establishing England's modern postal system. Babbage died in London in 1871, leaving more than 400 square feet of drawings for his Analytical Engine — a pivotal development in the history of computers.

u contributed by Kay S. Volkema

Barco, George J. (1907 – 1989)

American cable television pioneer, attorney, activist in the development of cable television policy, lecturer and humanitarian. George Barco is best known for his role as founder and owner of the original cable television system in Meadville, Pennsylvania, along with his position as General Counsel for the Pennsylvania Community Antenna Television Association (now Pennsylvania Cable Television Association) from 1956 to 1980.

George J. Barco was born on April 11, 1907, in Buffalo, New York, the son of Giacomo and Giacoma Battaglia Barco, immigrants who came to the United States from Cefalu, Sicily. He graduated from Meadville High School in 1926, where he was a member of the debating team and served as Class President during his junior year. He received a B.A. degree from Allegheny College in Meadville in 1930. He received his law degree from the University of Pittsburgh Law School in 1934.

Following law school, he served as Assistant District Attorney of Crawford County, Pennsylvania, from 1935 to 1939. From 1939 to 1943, he served as Deputy Attorney General in the Department of Justice for the Commonwealth of Pennsylvania. From 1945 to 1960, he was Solicitor for the Meadville Area School District of Crawford County, Pennsylvania.

On January 3, 1950, he formed the law firm of Barco and Barco with his oldest daughter, Yolanda G. Barco, as a junior partner. A member of the Pennsylvania Bar Association, he was a member of the Board of Governors, representing Pennsylvania Zone 7, from 1959 to 1962, and served on a number of committees for the organization. Barco was also a member of the American Bar Association.

In the early days of cable television, Barco worked to secure the rights for cable to operate as a public entity and fought for its right to attachment space on utility poles. In succeeding years, Barco successfully challenged the Pennsylvania Public Utility Commission's efforts to limit cable's access to utility poles. Barco eventually prevailed; the right to attachment space is noted in the Section 214 proceedings of the Federal Communications Commission (FCC). Barco also worked closely with the National Cable Television Association (NCTA) on the landmark Federal excise tax case which resulted in considerable tax savings for subscribers. The case, in fact, resulted in a refund of $25,000,000 in taxes that had previously been paid by subscribers.

In 1952, Barco founded and served as chairman of Meadville Master Antenna, Inc. (MMA). For the first several years of its existence, MMA was one of the largest cable systems in the United States. In fact, it was the first system in the country to use aluminum sheath cable. In 1962, the system was completely rebuilt to provide 12-channel capacity. MMA has been a forerunner in the development of cablecasting, which it has provided on a regularly scheduled basis since 1967.

In 1956, Barco was National Vice President of the National Community Television Association (now the National Cable Television Association) in Washington, D.C., and was President of the organization in 1957. In addition, he was a member of its Board of Directors from 1954 to 1966 and again from 1969 to 1972. He was also a Charter Member of Cable TV Pioneers.

A long-time proponent of public television, Barco helped organize, in 1964, the Educational Television of Northwest Pennsylvania, licensee of WQLN, which is Erie Channel 54. It is now known as Public Broadcasting of Northwest Pennsylvania, Inc. Barco was a member of its Board of Directors from 1964 to 1974 and was President from 1968 to 1970.

In 1979, he helped organize the Pennsylvania Educational Communications Systems (PECS). He served as Member and President of its Board of Directors during his ten years of affiliation with the organization. PECS is a Pennsylvania non-profit corporation composed of cable television companies operating in the state. Its purpose is to interconnect cable television systems for the distribution of PENNARAMA, a continuing education television service managed by Pennsylvania State University. A partnership between the cable television industry and all participating institutions of higher learning in the state, it provides television programming, including college credit courses, available on a 24-hour basis to cable subscribers in their homes.

Barco received an extensive list of honors and awards during his celebrated career. In 1967, he received the NCTA Larry Boggs Memorial Award for outstanding service, and in 1970 he was given the first George J. Schaefer Award for outstanding service to Educational Television Station WQLN. Throughout his career, he also was active in a number of civic organizations in Meadville, including the Chamber of Commerce, the United Way, American Red Cross, Boy Scouts of America, the Kiwanis Club, and many others.

On October 2, 1975, Barco was the guest of honor at a tribute dinner presented by the Pennsylvania Cable Television Association. The keynote speaker at this dinner was the late Milton J. Shapp, who was Governor of the State of Pennsylvania at the time, and is also known for his landmark work in cable television through his company, Jerrold Electronics. In honoring George Barco, the program noted his lifetime of service as “an untiring and effective advocate of cable’s right to exist, grow and develop.”

It is noteworthy that much of Barco’s work with the NCTA secured the right of cable television to carry a signal, which resulted in the basic right of cable television to exist. In his continuing work for the rights of cable television, he worked to fight the copyright litigation brought against the cable industry. This case was eventually heard by the Supreme Court of the United States. In June 1968, the Court ruled that cable television reception is not subject to copyright payment under the present law.

A defender of cable television’s right to exist and grow, Barco fought tirelessly against mounting regulations and restrictions that regulators have tried to impose upon the industry. He was a visionary in his belief in the capability of cable television to provide the public with a valuable service.

George J. Barco died on November 15, 1989. His oldest daughter, Yolanda, also very well known in the cable television industry, continues to run the law firm in Meadville, specializing in telecommunications law and general practice. Barco’s youngest daughter, Helene Barco Duratz, is a legal assistant for the firm.

u contributed by Valerie Switzer

Bardeen, John (1908 – 1991)

American electrical engineer, physicist and two-time winner of the Nobel Prize in Physics for co-inventing the transistor and for co-developing the BCS theory of superconductivity.

In 1908, Bardeen was born in Madison, Wisconsin. He stayed on there and received his bachelor’s and master’s degrees in electrical engineering from the University of Wisconsin. For the next three years, he worked at Gulf Research Laboratories as a geophysicist. He then obtained his doctorate in mathematical physics from Princeton in 1936. From 1938 to 1941, Bardeen worked for the University of Minnesota in Minneapolis. Then he was principal physicist at the U.S. Naval Ordnance Library in Washington, D.C., during World War II.

In 1945, Bardeen was hired by Bell Telephone Laboratories, where he researched electron-conducting properties of semiconductors. Working with colleagues Walter Brattain and William Shockley, Bardeen invented the point-contact transistor in 1947. This tiny device replaced the bulkier vacuum tube. It was able to switch current on and off much more quickly, generate less heat, use less power, and resist shocks better than its predecessor. Bardeen, Brattain and Shockley shared the 1956 Nobel Prize in Physics for inventing the transistor, which launched a revolution in microelectronics and greatly reduced the size and cost of computers.

From 1951 to 1975, Bardeen taught electrical engineering and physics at Illinois University. In 1957, with associates Leon Cooper and John Schrieffer, he developed the theory of superconductivity. Basically, this theory explains why some materials lose all resistance to electricity flow at temperatures near absolute zero. Called the Bardeen-Cooper-Schrieffer or BCS theory in their honor, it is the basis for all theoretical work in superconductivity. In 1972, the three men were awarded the Nobel Prize in Physics for this achievement.

John Bardeen died in 1991 in Boston, Massachusetts, the first man ever to receive the Nobel Prize in Physics twice and the recipient of numerous other honors.

u contributed by Kay S. Volkema

Bell, Alexander Graham (1847 – 1922)

Scottish-born American educator and audiologist, primarily known as the inventor of the telephone.

Bell was born in Scotland to a family with a long history of involvement in elocution, human speech and deafness. Although receiving some formal education in Edinburgh and London, he was largely family trained, particularly in areas of Bell family interest.

After both his brothers died from tuberculosis, Bell and his parents settled in Brantford, Ontario in 1870. Following in the family tradition, he began teaching deaf pupils in Boston, Massachusetts the next year. He opened his own school in 1872. When it became part of Boston University a year later, he was named professor of vocal physiology.

During this time, Bell joined forces with Thomas A. Watson, a repair mechanic and model maker. Financially supported by Gardiner G. Hubbard and Thomas Sanders (the visionary fathers of two deaf pupils), Bell and Watson devoted long nights to developing an apparatus for transmitting sound by electricity, while continuing their necessary day jobs.

The work paid off and on April 6, 1875, Alexander Graham Bell was granted a patent for his multiple telegraph. Then on March 7, 1876, Bell received U.S. Patent 174,465 for the telephone, one of the most lucrative patents ever granted. Three days later in Boston, he uttered the historic first words via telephone, “Mr. Watson, come here; I want you.”

The public learned about Bell’s invention at the 1876 Philadelphia Centennial Exposition, where it caused a sensation. Shortly after, in 1877, he co-founded the Bell Telephone Company with partners Gardiner Hubbard and Thomas Sanders and employee Thomas A. Watson. That year he also married his student and Hubbard’s daughter Mabel, who was 10 years his junior and deaf from early childhood.

Bell went on to accomplish many other things over the next 45 years. In 1880, the French government honored him with the prestigious Volta Prize for inventing the telephone. He used the award monies to found the Volta Laboratory, where in association with several others, he invented the graphophone to record sound. He also used the prize money to finance the American Association to Promote the Teaching of Speech to the Deaf and the Volta Bureau. The latter’s groundbreaking was attended by Bell’s prodigy, Helen Keller. In 1882, Bell officially became an American citizen.

Several years later, Bell was named President of the National Geographic Society. During his eight-year tenure, Bell’s future son-in-law, Gilbert Grosvenor, transformed the Society’s modest education pamphlet into the pictorial journal so well known today, *National Geographic Magazine.*

In 1915, Bell completed the first transcontinental telephone call from New York to his friend Thomas A. Watson in San Francisco.

He also is credited with inventing the audiometer for measuring sound intensity. In all, Bell was granted 18 patents in his name alone and another 12 with collaborators, for inventions ranging from telephones to hydroairplanes to a selenium cell. After he died in 1922, every Bell system telephone was respectfully kept silent during his funeral.

u contributed by Kay S. Volkema

Bell Atlantic Corporation

The regional Bell operating company (RBOC) that provides local phone service in six states — Delaware, New Jersey, Maryland, Pennsylvania, Virginia and West Virginia — and the District of Columbia, as well as cellular services, directory publishing and other information services.

Bell Atlantic, based in Philadelphia, is one of the seven regional Bell operating companies — or Baby Bells — created by the 1984 breakup of AT&T. Bell Atlantic provides local phone service in six northeastern states: Delaware, New Jersey, Maryland, Pennsylvania, Virginia and West Virginia, as well as in the District of Columbia. It also provides cellular services in 15 states and in the District of Columbia and publishes the Yellow Pages directories for the Bell Atlantic region. The company shares Bell Communications Research (Bellcore) with the six other RBOCs.

Bell Atlantic has evolved from the AT&T/Bell System born in the 1870's. Although Bell Atlantic's mature market experiences less than 4% annual growth, the company continually works to improve quality and offer new service options. For instance, it pioneered services such as caller ID and call waiting and began fiber optic testing in 1990. Bell Atlantic's acquisition of Metro Mobile, one of the nation's largest independent cellular providers, gave the company the most extensive cellular phone coverage on the East Coast. A strategic partnership between Bell Atlantic and fellow RBOC NYNEX will combine their existing cellular services and develop wireless communications capabilities in national markets. In addition, Bell Atlantic's computer service division provides hardware maintenance, software support and disaster recovery services for over 640 brands of computer equipment.

Among its restrictions, the 1984 antitrust settlement between AT&T and the U.S. government prohibited the RBOCs from offering information services and video entertainment. In 1991, however, the U.S. District Court removed the ban prohibiting RBOCs from offering information services. Other decisions have lifted most restrictions against providing video services. These rulings have opened the way for Bell Atlantic to vigorously enter these markets.

In December 1993, Bell Atlantic announced a five-year, $15 billion plan to pave a portion of the information highway. The plan calls for wiring nearly 3 million homes for interactive services by the end of 1996, and having the capability to deliver interactive services to nine million households by the end of the decade. Bell Atlantic is developing systems for delivering traditional multichannel programming, as well as interactive multimedia programs. Its *ISDN Anywhere* initiative will expand the telephone networks' current capabilities to support simultaneous voice, data and video applications. Also, the company is working with Oracle to create *Stargazer*, an interactive shopping, entertainment and information service. Bell Atlantic was the first RBOC to offer video programming and telephone service in the same territory.

While a proposed 1993 Bell Atlantic merger with Tele-Communications, Inc. (TCI) — the world's largest cable company — did not materialize, Bell Atlantic continues to pursue joint ventures in the burgeoning home entertainment and interactive services arena. In late 1994, Bell Atlantic, NYNEX and Pacific Telesis announced a partnership to create home entertainment, information and interactive services. To develop innovative programming, the partners have also formed a strategic relationship with Creative Artists Agency, Inc. The technology side of the initiative is dedicated to providing the systems necessary to deliver programming over the participating telephone companies' new video dial tone (VDT) networks.

In March 1995, Bell Atlantic received a waiver from the consent decree that broke up AT&T in 1984. The waiver allows Bell Atlantic to transmit video and other signals across local telephone boundaries. The action is important because it permits the company to send and receive video and other signals nationwide by satellite as cable television companies currently do. This action further guarantees Bell Atlantic's full participation in the global information highway.

Internationally, Bell Atlantic seeks investment opportunities in foreign telecommunication companies, and offers management consulting, technological services, and training to telephone companies, governments, and large businesses outside the United States. In partnership with RBOC Ameritech, Bell Atlantic owns New Zealand's public phone systems. The company helped modernize Spain's network, and, in collaboration with RBOC U S WEST, made cellular services available in three Czechoslovakian cities. In 1993, Bell Atlantic bought 23% of Mexico's telephone system. Interests in Italy include cellular and software development. Through joint ventures with leading Asian and European information technology companies, Bell Atlantic also provides computer services in western Europe and Asia.

u contributed by Susan P. Sanders

Smith, Raymond W. (1937 –)

American business executive, currently Chairman and Chief Executive Officer of regional Bell operating company (RBOC) Bell Atlantic Corporation.

Raymond Smith is a native of Pittsburgh, Pennsylvania, where he was born in 1937. Circumstances had prevented his parents from finishing school; his father began laboring in a steel mill at age 13, and his mother left school at the same age to work in her family's bakery. Raymond Smith's mother, however, was determined that her bright and energetic only child would not end up a laborer. The work ethic the Smiths instilled in Raymond was evident as he worked his way through college earning A's and B's. Smith received an electrical engineering degree from Carnegie Mellon University in 1959, and joined the Bell System in Pennsylvania the same year.

Throughout his long career with the telephone company, Smith has held positions in diverse areas including operations, engineering, public relations and finance. For ten years, he also attended night classes at the University of Pittsburgh, completing his MBA in 1967. After serving as Director of Finance and Budgets at American Telephone and Telegraph (AT&T), Smith was named Pennsylvania Bell's President in 1983. In 1989, he was named Bell Atlantic's Chief Executive. Part of Bell Atlantic's corporate folklore is the story that Smith, constantly frustrated by AT&T's slow-moving bureaucracy, gathered his colleagues after the announcement of AT&T's divestiture and led a rousing chorus of *Free At Last.*

Raymond Smith is well-known as a champion of civil rights and equal opportunity. His efforts earned him the honor of being the first recipient of the National Association of Black Telecommunications Professionals' Mickey Leland Award for Diversity in Telecommunications. Smith, who once studied literature at Duquesne University, also has been a playwright and theatrical director since 1971. While his dramatic resume is impressive, Smith has often been quoted as saying that he "has no plans to quit his day job."

In addition to his other activities, Smith serves on a House of Representatives advisory board for Renewing U.S. Science Policy, as well as advisory boards for The Business Roundtable and the Library of Congress. He is a member of the National Information Infrastructure Advisory Council, advising the U.S. Commerce Department on telecommunications policy. In 1995 he was appointed by President Clinton to the President's Committee on the Arts and Humanities.

In 1987, Smith directed a play he authored entitled *The Fetal Pig*. The play tells a story of four friends nearing their fiftieth birthdays who have achieved little in their lives. Obviously, the play does not reflect Raymond W. Smith's own life story.

u contributed by Susan P. Sanders

Bell Laboratories (AT&T Bell Laboratories, Inc.)

Also known as **Bell Telephone Laboratories** and **Bell Labs**. A research and development company owned by American Telephone & Telegraph Company (AT&T), specializing in telecommunications equipment development. Headquartered in Murray Hill, New Jersey, Bell Labs is one of the world's pre-eminent research facilities.

Bell Telephone Laboratories, Inc. was incorporated in 1925, but it had existed since 1883 as the Mechanical Department of the Bell Telephone Company. In 1907, John J. Carty, chief engineer of AT&T, consolidated into one entity the many research, development and engineering groups of Western Electric, American Bell, AT&T, and the local Bell operating companies. Called the Western Electric Engineering Department, it was housed at AT&T offices in New York City. President Frank B. Jewett was at the helm when Bell Telephone Laboratories incorporated in 1925. Nine years later, Bell Labs merged with AT&T's remaining research and development group. This created the world's largest engineering organization, led by Bell Labs Vice President D. E. H. Colpitts.

Bell Laboratories has always been at the forefront in advancing scientific and telecommunications research and development. In 1926, the first synchronous-sound motion picture system was established in Bell Labs. In 1927, years of Bell research culminated in transatlantic radiotelephone service being made available to an eager public. In 1936, Bell researcher George C. Southworth announced his co-invention of the coaxial cable with Dr. Wilmer L. Barrow of MIT. In 1937, the pioneer electrical-relay digital computer was constructed at Bell Labs. Clinton Davisson, a Bell researcher, shared the Nobel Prize in Physics that year for demonstrating the wave nature of matter.

In 1947, Bell associates John Bardeen, Walter Brattain and William Shockley invented the transistor, a communications breakthrough for which they received the 1956 Nobel Prize in Physics. In the 1970's, Bell Labs developed the cellular remote telephone system. And in 1978, Bell researchers Arno Penzias and Robert W. Wilson shared the Nobel Prize for discovering cosmic microwave background radiation.

After AT&T's divestiture in 1984, 3,000 employees were forced to leave Bell Labs to help staff Bell Communications Research (Bellcore). Headquartered in Livingston, New Jersey, this separate research center's function was to service the seven new regional Bell operating companies (RBOCs).

In addition to its continuing telecommunications work today, Bell Labs is contracted with the U.S. government for important defense research and development.

Over the years, Bell Laboratories has made thousands of contributions to science, engineering, and telecommunications. Today, Bell researchers continue to do innovative work and to publish important technical and scientific papers, retaining Bell Labs' leadership position worldwide — a position it has enjoyed for over a hundred years.

u contributed by Kay S. Volkema

Stanzione, Daniel C. (1945 –)

American business executive and expert software scientist, currently President of AT&T Bell Laboratories (Bell Labs).

Daniel C. Stanzione earned his BS degree in electrical engineering from South Carolina's Clemson University in 1967. He received his master's in environmental systems engineering in 1968 and his doctorate in electrical and computer engineering in 1972, both also from Clemson. Stanzione joined AT&T Bell Laboratories in 1972 as a software developer.

Throughout his career with Bell Labs, Stanzione has been instrumental in the introduction and integration of state-of-the-art technology. For example, he led the team that developed the first digital signal processor, and was a vital participant in technology advances in asynchronous transfer mode (ATM) systems. Stanzione holds two patents in computer architecture.

In 1978, Stanzione became Head of the Network and Integrated Circuit Design Department; in 1985, he was named Executive Director of the Transmission Operations Division. After serving as President of the Operations Systems Business Unit in AT&T Network Systems and in other positions, Stanzione became President of AT&T Network Systems' Switching Systems Unit. He is credited with being a major contributor to AT&T Network Systems' marketplace success.

In January 1995, Daniel Stanzione was appointed President of AT&T Bell Laboratories, the eighth President since Bell Labs was established in 1925. He replaced John S. Mayo, who had reached AT&T's mandatory retirement age. In his position as Bell Labs President, Stanzione also serves on AT&T's Executive Committee. Stanzione's extensive senior management experience and background as a veteran software scientist strengthens Bell Labs' ability to sustain AT&T's competitive advantage through technology.

u contributed by Susan P. Sanders

BellSouth Corporation

The regional Bell operating company (RBOC) — also known as a Baby Bell — that provides local phone service, cellular, directory publishing and other information services in the southeastern United States and other areas.

Atlanta-based BellSouth, with over 19 million lines, is the largest of the seven regional Bell operating companies (RBOCs) — also known as Baby Bells — created by the 1984 breakup of the Bell system. BellSouth's local telephone operations serve more than 50 million customers in its nine-state southeastern U.S. region. In Florida, Georgia, North Carolina and South Carolina, BellSouth does business as Southern Bell; in Tennessee, Louisiana, Kentucky, Alabama and Mississippi, it operates as South Central Bell. With 95,000 employees, the company has operations in 48 states and 16 countries on five continents. BellSouth shares Bell Communications Research Inc. (Bellcore) with the other six RBOCs.

Under CEO John Clendenin, technology development and strategic marketing are making wireless services a primary factor in BellSouth's growth. In fact, revenues from wireless communications increased over 30 percent in 1993. BellSouth, the only cellular carrier to also operate a nationwide paging license, has more than four million cellular, paging and mobile customers worldwide. The company's U.S. cellular telephone operations are located in its own region, as well as other Baby Bell market areas including Los Angeles, Houston and Milwaukee.

BellSouth is pushing forward in converting from analog to digital technology in U.S., Asian and European markets. In addition, it has installed more than one million miles of advanced high-capacity optical fiber throughout its network. To expand into the growing video services arena, BellSouth has invested in Prime Management, a small Austin, Texas-based cable operator serving about 500,000 cable subscribers. The RBOC is also developing interactive services, and is planning an Atlanta-area trial system for 12,000 homes that will offer 60 traditional television channels and up to 300 interactive services channels.

Using its expertise and resources, BellSouth has developed the capability to quickly launch overseas cellular operations. For instance, cellular services in both Buenos Aires and Australia were implemented within months after licenses were awarded. The company also provides cellular services in countries throughout Europe, Asia and South America. BellSouth has wireless data operations in countries including Australia, Singapore, France, the United Kingdom and the Netherlands; offers long distance services in Chile; and has interests in Chinese telecommunications projects.

For six years, *Fortune* magazine has rated BellSouth as the nation's most respected Bell operating company.

u contributed by Susan P. Sanders

Clendenin, John L. (1934 –)

American business executive, currently Chairman and Chief Executive Officer of BellSouth Corporation, a regional Bell operating company (RBOC).

John L. Clendenin was born in El Paso, Texas, on May 8, 1934.
In 1955, Clendenin received his BA degree from Northwestern University in Evanston, Illinois, and later served as a pilot in the U.S. Air Force Strategic Air Command.

Clendenin began his lifelong telecommunications career with the Illinois Bell Telephone Company in 1955, and became a Vice President in 1975. In 1978, he moved to Seattle to join Pacific Northwest Bell Telephone Company as Vice President of Operations, and in 1979 became an American Telephone and Telegraph (AT&T) Vice President based in New York. Clendenin was elected President of Southern Bell in April 1981 and became Chief Executive Officer of the BellSouth Corporation on January 1, 1984, with the divestiture of AT&T.

In addition to his responsibilities at BellSouth, Clendenin serves on corporate boards for organizations including Providian Corporation, the Kroger Company, Coca-Cola Enterprises, Inc., Wachovia Corporation and the New York Stock Exchange. He is a former National President for the Boy Scouts of America, and past Chairman of the U.S. Chamber of Commerce and the National Alliance of Business. Clendenin is Chairman of the Committee for Economic Development, and serves on the Board of Governors of the American Red Cross and the Policy Committee of the Business Roundtable.

u contributed by Susan P. Sanders

Bell Communications Research (Bellcore)

A corporation established January 1, 1984, following the federally mandated divestiture of American Telephone and Telegraph (AT&T). Bellcore provides communications software, consulting and training for the seven regional Bell operating companies (RBOCs).

Headquartered in Livingston, New Jersey, Bell Communications Research (Bellcore) is a telecommunications organization that was established to provide technical support software systems and training to the seven regional Bell operating companies: Ameritech, Bell Atlantic, BellSouth, NYNEX, Pacific Telesis, SBC Communications and US West.

In 1991, members of Bellcore's Board of Directors elected Dr. George H. Heilmeier President and Chief Executive Officer. He previously had served as Senior Vice President and Chief Technical Officer of Texas Instruments Incorporated, and also worked in research for the United States Department of Defense.

In the last few years, Bellcore has been honored by the telecommunications industry for a number of achievements. In 1994, it received the Institute of Electrical and Electronic Engineers' (IEEE) Corporate Innovation Recognition Award for initiating the concept, establishing detailed specifications and promoting the development of synchronous optical networks. Better known as SONET, this new fiber optic system is a technically advanced format that allows transmission of digital information from a variety of different sources through a fiber optic ring. This could include digitized voice, visual images, and data, all transmitted from one source. Bellcore is also known for its development of the Telecommunications Network for the Deaf.

Bellcore's other recent projects include the implementation of Personal Access Service for Bell Atlantic, Single Number Service for Pacific Telesis, and Transaction Switching and Transport Service for all seven of Bellcore's owner companies. Bellcore also licenses its products to other telecommunications companies.

Bellcore TEC, the company's Training and Education Center headquartered in Lisle, Illinois, provides in-depth training in telecommunications. In 1993, Bellcore provided more than 150,000 days of student training to staff members from 300 industry clients and owner companies. Also in 1993, Bellcore TEC, through its tele-training network, reached more than 7,000 individuals through eight live, interactive broadcasts to customers in the continental United States, Hawaii and Canada.

In addition to providing more technologically advanced products and services, Bellcore serves as the single point of contact for coordination of communications services associated with national security and emergency preparedness. In the early 1990's, following the World Trade Center bombing in New York City, and during and after the devastating floods in the Midwest, Bellcore provided emergency technical support to the regional Bell operating companies in those areas. It also provided emergency assistance during more than 250 other telecommunications network emergencies throughout the United States in 1993.

Bellcore was a contributor, in 1994, to the formulation of the policy statement on the National Information Infrastructure (NII). This document, in its final form, was signed by the CEOs of 14 of the nation's leading telecommunications companies. It was then presented to President Bill Clinton. The policy structure announced by the Clinton Administration shortly thereafter was basically the same as that presented by these key industry leaders.

Bellcore holds 391 patents in the United States and 112 foreign patents. With an employee base of more than 6,200 people and an operating budget in excess of $1 billion, its goal is to provide world-class research and integrated business solutions for businesses around the world.

u contributed by Valerie Switzer

Biondi, Frank J., Jr. (1944 –   )

American business executive who started his career on Wall Street, got involved in television and quickly rose through the ranks to currently head media giant Viacom International. He is credited with being a key player in one of the few successful leveraged buyouts of the 1980's.

A savvy executive, strategic thinker, and skilled manager with a penchant for running herd on a diverse group of young executives at Viacom, CEO Frank J. Biondi says his job is not about deciding what movies to make or books to publish, but "to set goals, find resources in both capital and people, and understand the basic dynamics of business. Aside from that, it's basically to get out of the way."

Since 1987, Biondi has been president and CEO of Viacom, Inc. overseeing a $9 billion empire with operations in 142 countries. Viacom is a media giant that owns cable and premium networks. Viacom also produces and distributes television programming and feature films, develops and publishes interactive software, owns cable systems, and owns television and radio stations. Biondi has the day-to-day task of managing one of the world's top media conglomerates.

A good complement to Viacom's strong-willed chairman, Sumner Redstone, Biondi is a personable, even-tempered executive. He is respected, well-liked, and reported to prefer negotiation to confrontation. All of his skills will be put to the test with the consolidation of Viacom's acquisition of Paramount Communications and Blockbuster Entertainment and its expansion into the international market.

Biondi is a Princeton graduate with a Harvard MBA Although he started a Wall Street career with Shearson Lehman Hutton and Prudential Bache, Biondi later started his own financial consulting firm. It was through this venture that he became involved with the Children's Television Workshop, his entree into the television industry.

In 1978, Michael Fuchs, then Programming Chief at Home Box Office, Inc. (HBO), enticed him to join the pay-TV company (now a unit of Time Warner Inc.) as its Director of Entertainment Program Planning. Biondi rose quickly through the ranks at HBO and from 1983 to 1985 he served as Chairman and CEO. Growth was HBO's objective, and Biondi aggressively positioned the company through exclusive contracts for movie rights, primarily with Coca-Cola's Columbia Pictures unit.

When the pay-TV business hit a slump and the growth strategy proved too costly for HBO , Biondi was forced to resign. The sabbatical was short-lived, however. Biondi was seen as a brilliant entertainment acquisitions strategist, and Coke's Columbia Pictures unit offered him a job as Executive Vice President. This position resulted in Biondi's close involvement with Coke's $485 million acquisition of Embassy Communications Inc. in 1985 and its $200 million purchase of Merv Griffin Enterprises.

In the summer of 1987, Sumner Redstone offered Biondi the CEO post at Viacom in New York. In what was soon seen as an excellent career decision, he said yes. Columbia was later sold to Sony Corp. Shortly afterward, Sony replaced all the top managers.

Working closely with Redstone, Biondi is credited with taking Viacom through one of the few successful leveraged buyouts of the 1980's. After Redstone acquired Viacom in 1987 for $3.4 billion, he and Biondi spent much of the next three to four years painstakingly restructuring its debt. This meant getting out of the junk bond market, discarding nonessential assets, and focusing on expanding Viacom's MTV and Nickelodeon franchises worldwide.

A devoted family man, Biondi is married to Carol and has two teenage daughters. He is an avid skier and tennis player who acknowledges that he's "extremely competitive."

u contributed by Diana L. Hollenbeck

Editor's Notes:
In January, 1996, Sumner Redstone fired Frank J. Biondi, Jr. and created an executive committee to oversee the operations of Viacom Inc. Analysts and investors were surprised by the ouster, and many people suggested that Viacom's woes cannot be blamed on Biondi's management style.

Bits and Bytes

Bits are the smallest unit of information that a computer processes. A bit is the equivalent of one pulse of electricity in a circuit. A string of eight bits, known as a byte, can represent a standard keyboard character.

Although computers handle an array of information, they can only do so by converting the information into numbers. Unlike our number system and letter system, which includes digits zero through nine and “a” through “z,” digital computers use a binary system with only two digits: one and zero. That is because a computer is able to represent the one and zero as the presence or absence of an electrical charge. Presence of electricity represents “one” and absence of electricity represents “zero.” The ones and zeros constitute information *bits*, which is an amalgam of the words *bi*nary digi*ts*. The computer groups these ones and zeros together in sequences that resemble Morse code. A string of eight bits, called a byte, contains enough possible on/off combinations to represent every number, letter, space and character on a standard English keyboard. Personal computers use a standard code to combine bits into numbers and letters called the American Standard Code for Information Interchange (ASCII). ASCII allows different types of computers to share information with each other. Larger computers sometimes use other codes in addition to ASCII. Chief among them is a code used by IBM computers called Extended Binary Coded Decimal Interchange Code (EBCDIC).

u contributed by Christopher LaMorte

Brattain, Walter Houser (1902 – 1987)

American scientist, physicist and winner of the Nobel Prize in Physics for co-inventing the transistor, which revolutionized electronics.

Brattain was born in Amoy, China in 1902. He spent his youth in Washington state and was educated at the universities of Oregon and Minnesota.

In 1929, he became a research physicist at Bell Telephone Laboratories, where he worked for 38 years. Working with Bell associates John Bardeen and William Shockley, Brattain invented the point-contact transistor in 1947. This minute device replaced the bulkier vacuum tube. It was able to switch current on and off much more quickly, generate less heat, use less power, and resist shocks better than its predecessor. Brattain, Bardeen and Shockley shared the 1956 Nobel Prize in Physics for inventing the transistor, which launched a revolution in microelectronics and greatly reduced the size and cost of computers.

Brattain retired from Bell in 1967, then served as adjunct professor at Whitman College in Washington until 1972. Over his lifetime, he wrote many articles and received a number of patents in the field of solid-state physics. Walter Brattain died in Seattle, Washington, in 1987 at the age of 85.

u contributed by Kay S. Volkema

Bresnan, William J. (1933 –)

American businessman and cable pioneer, currently President of Bresnan Communications, Inc. Armed with extraordinary technical expertise, Bresnan has been instrumental in the technological development of the cable television industry.

A graduate of South Central College, Mankato, Minnesota, native William J. Bresnan began his career in 1958 when he designed and built his first cable system in Rochester, Minnesota, for a group of local investors. Seven years later, that company was acquired by Jack Kent Cooke, Inc. and Bresnan was named Vice President of Engineering for the new company. Within a short time he was named Executive Vice President. After several mergers, Cooke was named Chairman of Teleprompter Corporation and Bresnan was made President of Teleprompter's Cable Television Division (1974 to 1981). He was also a member of the Board of Directors and the Executive Committee of Teleprompter Corporation (1972 to 1982), including a stint as Chairman of the Board (1972 to 1973).

Westinghouse Electric Corporation purchased Teleprompter in 1981 and Bresnan was named Chairman and Chief Executive Officer of the new company, Group W Cable, Inc. From 1982 to 1984 he was a member of the Board of Directors of Westinghouse Broadcasting and Cable, Inc.

In 1984, Bresnan left Group W Cable and founded Bresnan Communications, Inc., headquartered in White Plains, New York. The company owns and operates cable systems in approximately 210 communities, serving 207,000 customers in Georgia, Michigan, Minnesota, Mississippi, and Wisconsin. The company is also active internationally with cable operations serving 218,000 customers in Chile and Poland.

As one of the industry's leading contributors to technological development, and granted special authority by the Federal Communications Commission (FCC) and the Canadian Radio and Television Commission, Bresnan played a major role in sending the first domestic satellite transmission using a Canadian ANIK satellite (1973). He was also instrumental in the first use of optical fibers in a U.S. commercial communications system (1976).

Bresnan's lengthy career has included a leadership role in the shaping of the cable television industry. In 1975, *Cable News* named him "Man of the Year" for his exceptional service to the industry. A member of the National Cable Television Association's (NCTA) Board of Directors for more than 20 years, he was a member of its Executive Committee for 15 years. For outstanding contributions to the industry, Bresnan was presented the NCTA's prestigious Larry Boggs Award in 1981 and the President's Award in 1987.

Bresnan is committed and involved, both professionally and personally. Married to Barbara with three sons and three daughters, this Scarsdale, New York, resident finds time to serve on the boards of directors for an impressive list of industry organizations, as well as holding membership in many of the industry's technical organizations. For his firm commitment to the advancement of women throughout the industry, Bresnan is an honorary lifetime member of Women in Cable and Telecommunications. He is a founding member of the Floyd Patterson Children's Fund and holds a seat on the Advisory Council of Mankato State University College of Business.

u contributed by Diana L. Hollenbeck

Broadcast Radio: History and Development

The Information Age, as is sometimes believed, did not really begin in the latter half of the twentieth century. Its roots first began to sprout during the closing days of the Victorian era, in the late 1800's, with the advance of basic scientific theories and rudimentary communication technologies. But it was the blooming of broadcast radio in the 1920's that signaled the real beginning of our current information era.

According to historian Eric Barnouw, distraught and dislocated families of the Great Depression, desperate for a word of hope or a reason to smile, discarded almost all other worldly possessions except their radios to survive. Little did they know that what they clung to in those dark, desolate days was the very heart of a technological wonder that would transform the world .

Radio Technology: Rudimentary Research and Inspired Insights

Some of the basic scientific concepts that explain how broadcast radio actually works (for example, magnetism and electricity) were first discussed thousands of years ago. But the principles that make up the theoretical basis for radio broadcasting were put forth most clearly by two men of science in the late 1800's.

From 1865 to 1873 a British mathematician, James Clerk Maxwell, released a series of papers outlining the existence of an invisible form of radiating energy that was similar to light, but distinctly different. Maxwell had identified electromagnetic energy. Little more than a decade later, in 1888, German physicist Heinrich Hertz developed the laboratory experiment that proved Maxwell's electromagnetic energy did indeed exist. As a lasting tribute to his groundbreaking work, electromagnetic energy is now measured in Hertz (Hz) or cycles per second.

New Discoveries Put Voices in the Air

Like every great invention, radio needed certain catalysts to boost its development at crucial times. One of broadcast radio's most important innovators was Guglielmo Marconi . Not only did he have the imagination and the dedication of an inventor, but he also had the business sense to transform his ideas into a marketable commodity.

As a 20-year-old, the young Italian was galvanized by Hertz's experiments and the idea of sending messages without wires or cables. Barely a year after first hearing of Hertz's work, Marconi's experiments enabled him to send and receive a signal over a mile's distance. Marconi knew the only obstacle that stood in his way was distance. He addressed that issue by continually extending the height of his antennas.

In 1896, Marconi relocated to Great Britain and, at the age of 22, patented his equipment and plowed ahead with his experiments. While he worked, he also kept an eye on commercial possibilities, establishing companies in Great Britain and the United States. Finally, on December 12, 1901, he was able to transmit the letter s in Morse code more than 2,000 miles from Poldhu, England, to the shores of St. John's, Newfoundland. By 1913, Marconi's U.S. subsidiary had a virtual monopoly on American wireless telegraphy communications.

In the early 1900's, a number of important technological advances were made that brought the transmission of voice and sound even closer. In 1900, Reginald Fessenden and a General Electric (GE) colleague, Ernst Alexanderson, developed an alternator that could produce a continuous, high-frequency wave capable of carrying sound signals. In 1904, Marconi adviser Sir Ambrose Fleming created the first two-element vacuum tube (a diode), which vastly improved the detection of airborne signals.

Just three years later, Lee de Forest, a Yale-educated engineer, made a critical improvement on the diode. By introducing a third element to Fleming's vacuum tube (thereby creating a triode), he was able to greatly improve the tube's efficiency in detecting incoming signals. De Forest continued working on the triode, or Audion tube as he called it, and discovered it performed two other critical tasks. Not only could it amplify signal strength, but when oscillated the Audion tube also generated a continuous, high frequency wave capable of carrying sound, music or speech.

From Wireless Telegraphy to Broadcast Radio

Marconi's success in developing an apparatus to transmit telegraph signals over vast distances was quick to catch worldwide attention. One of its first widespread uses was for communications in the maritime services, both for private shipping and operating naval forces.

A number of dramatic incidents focused public attention on wireless telegraphy. By far the most notable was the 1912 maiden voyage of the *Titanic*, when the unsinkable vessel hit an iceberg and began to sink . Urgent messages were sent out over the ship's wireless. 58 miles away, the *Carpathia* changed course and steamed toward the stricken ship. Yet just 10 miles away, the *Californian's* wireless operator was off duty and his equipment shut down. Though 706 survivors were plucked from icy waters, more than 1,500, including one wireless operator who stayed at his station until the end, perished. All the while, land-based wireless operators monitored the tragedy through the messages being sent back and forth between the sinking ship and rescuers.

With incidents like this, the benefits of transoceanic wireless telegraphy had become well established by the early 1900's. But its limits were also readily apparent. Wireless voice and sound communications were the next goal. And one of broadcast radio's most dedicated proponents was happy to oblige.

On Christmas Eve in 1906, Reginald Fessenden made what is considered the first radio broadcast from a wireless station he had established south of Boston at Brant Rock, Massachusetts. Using one of the alternators he had developed, Fessenden's broadcast consisted of the inventor playing the violin, singing and reading from the Bible. Ship-based wireless operators far out at sea were astounded to hear voices and music coming out of earphones that had previously produced only static-filled Morse code messages.

Continuing his research after the success of the Audion tube, Lee de Forest used his knowledge to move radio broadcasting closer to reality. In 1907, he began making experimental broadcasts over his wireless telephone from New York City. By 1916, he was using his Audion tube as an oscillator to transmit radio waves. This electronic means of generation would prove more effective and efficient than Fessenden's mechanical alternator.

Sarnoff's Vision Maps Radio's Corporate Future
Yet it was a lone visionary at American Marconi who, in 1916, foresaw the true potential of radio broadcasting. In a famed letter now dubbed the Radio Music Box Memo, a young David Sarnoff, future RCA leader and industry icon, detailed the future of radio as he saw it.

In the memo addressed to Marconi manager Edward Nally, Sarnoff envisioned a development plan that would make radio a Ôhousehold utility' in the same sense as the piano or phonograph. Sarnoff's Radio Music Box as he called it, would be easy to operate and allow listeners to tune into different wavelengths. He felt that its uses would go beyond relaying just music, possibly even to announcing baseball scores.

From the time Sarnoff wrote his prescient memo in 1916 until 1920, when the first commercial broadcast took place, a major shift in the burgeoning radio industry took place: one that would shape its development for decades to come.

Leading up to World War I, the airwaves, which were largely unregulated, were jammed with amateur wireless operators. However, this amateur status was soon to change. A number of key corporations were beginning to see the growth potential of radio and were moving into position to take advantage of it. The companies that played a key role in broadcast radio's emergence and almost overnight success included Westinghouse, American Telephone and Telegraph (AT&T), Western Electric (AT&T's manufacturing company) and General Electric (GE).

Unfortunately, while they were all scrambling for position, they acquired different patents, many of which needed to be combined to make an effective radio receiver. The Audion tube was under AT&T's wing; GE had rights to Alexanderson's alternator; and Westinghouse claimed Fessenden and Armstrong's work, to name a few.

Broadcast Radio Industry Takes Shape
Added to this patent stew was the United States Navy's distrust of Marconi's companies in Great Britain and the United States. When GE moved to sell Alexanderson's alternator to Marconi interests, the Navy tried to halt the sale, fearing the total domination of wireless communications by Marconi. GE overcame Navy objections by essentially creating a new customer for its alternator. It formed its own international communications company, the Radio Corporation of America (RCA), in 1919.

Marconi realized what was happening and knew the American wireless market was closing to foreign-owned interests. Rather than fight the inevitable, American Marconi sold its U.S. holdings to RCA. The other communication companies — AT&T, Western Electric and Westinghouse — soon joined RCA as shareholders. With RCA as a convenient umbrella organization, the competing companies soon came to agreement on crucial licensing issues, thus allowing them to share more than 2,000 patents.

The agreements, hammered out from 1919 to 1921, appointed RCA as the sales and marketing agent for radio sets manufactured by GE and Westinghouse. Meanwhile, AT&T and its manufacturing subsidiary, Western Electric, got the rights to produce, sell and lease commercial transmission equipment. The stage was set for receiver production, so all that was needed was the demand from the public.

Consumer Demand Catches On

The catalyst for consumer demand was found in a Westinghouse engineer, Frank Conrad. Before the war, Conrad was an active amateur wireless broadcaster, sending out recorded music over the airwaves. Once the federal government relinquished its wartime control of wireless operations in 1920, Conrad went back on the air, eventually on a regular twice-a-week schedule. Local papers began talking about the broadcasts and his audiences grew. A local department store, realizing it had the makings of a real sales drive on its hands, reported in newspaper ads that the radio sets in stock could be used to listen to Conrad's shows.

A Westinghouse executive, H.P. Davis, saw the department store ad and recognized radio's potential. He contacted Conrad and recommended a daily broadcast schedule. Westinghouse then applied for and received a commercial license for the new station, which received the call signals of KDKA. The nation's first commercial station went on the air November 2, 1920, with results from the Harding-Cox presidential election. Vote totals were telephoned from a newspaper office to KDKA's makeshift studio in a Westinghouse warehouse. The show got the attention of the entire country when it received national press coverage.

At first, because KDKA didn't have any other signals to compete with, its signal could be received at great distances. More and more newspapers began publishing its broadcasting schedule. During the first year of operation, the station introduced many types of programs that would eventually become industry standards: public service announcements, financial reports, dramas, church services, sporting events, political speeches and orchestra music.

But competition wasn't far behind. While there were only 20 new stations licensed by the end of 1920, radio sales soared, with 100,000 receivers sold in 1922 alone. This increase in radio sales spurred station growth. By the summer of 1922, more than 200 stations had been licensed. And, by the end of 1923, that number had already doubled with more than 575 licenses issued.

Broadcast Radio Goes Commercial

For all the success that KDKA and other early stations enjoyed, an important part of the broadcast radio industry, as it would become known, was still missing — advertising. The first two years of commercial broadcasting were based largely on the KDKA concept, with each station owned by an individual company. This exclusive ownership gave that company its own voice in the expanding broadcast marketplace.

Unfortunately, this concept ran into the reality of programming budgets. As the number of stations and the amount of competition increased, so did the cost of producing shows. The rising costs of production, talent and the technology of broadcasting quickly put exclusive ownership of stations out of reach for many, if not most, companies. A better business structure was needed.

AT&T found the solution to the problem. Extending its telephone philosophy, the company provided the communications tool, and whoever paid for it could say whatever they wanted. This idea of toll broadcasting, as advertising was first known, was instituted on AT&T's New York radio station WEAF on August 22, 1923. The first commercial was a 10-minute spot for a real estate company extolling the virtues of Hawthorne Court, a new apartment complex on Long Island. And so radio advertising was born.

Over the next few years, AT&T experimented with establishing small networks, or broadcasting chains, for special events and an abbreviated broadcasting schedule for six stations linked over special AT&T telephone lines. Demand for radio receivers and broadcasting equipment exploded, and the participants of the original licensing agreements of 1921 were sued in federal court. The suit claimed the licensing agreements violated antitrust laws because signatories of the agreements were controlling the production and sales of all radio equipment.

As a result of the mounting pressures, AT&T reassessed its position and decided to restrict its focus to telephone operations. Its broadcasting operations were then sold to GE, Westinghouse and RCA. In turn, RCA promised to use AT&T network relays exclusively. Network broadcasting was dawning, and it was going to be financed by toll broadcasting or advertising.

Radio Networks Take Hold and Grow

Not too surprisingly, the first network formed was by RCA shortly after it acquired AT&T's broadcasting assets. On November 15, 1926, the National Broadcasting Company (NBC) beamed its inaugural program coast-to-coast with 25 stations reaching an estimated 5 million people. In 1927, NBC, rapidly expanding under the leadership of David Sarnoff, found itself with two stations in a number of markets. The network was then split into two semiautonomous (Red and Blue) networks, and NBC exploited its double-exposure advantage in these key markets as much as possible.

Shortly after NBC went on the air, a disgruntled talent agent, Arthur Judson, became frustrated in his efforts to get his client performers exposure on the new network. Unable to break into NBC, he started his own network, called United Independent Broadcasters, in 1927. Finances were always precarious for the shoestring operation; investors came and went, including the Columbia Phonograph and Records Company. By 1928, things had deteriorated considerably when William S. Paley, the son of one of the network's advertisers, stepped in and bought the network for less than $400,000.

The network had 22 affiliates on its roster when Paley took over and renamed the network Columbia Broadcasting System (CBS). He set about rewriting the affiliate contract to recruit more stations. In just three years, in the depths of the Great Depression, the network posted a profit of more than $3 million. Then, seven years later, Paley bought out one of the network's original owners, the Columbia Phonograph and Records Company. Under Paley's direction, CBS Records, as it would eventually be known, became a world leader in the recording industry.

Shortly after NBC and CBS took to the airwaves, four independent stations (WGN/Chicago, WOR/New York, WLW/Cincinnati and WXYZ/Detroit) formed their own cooperative network called the Mutual Broadcasting System in 1934. Originally started as a cooperative way to purchase advertising, the network did eventually circulate programs originated by the individual stations. During the late 1930's the network established its own production facilities and gained wide success with such shows as *The Shadow*, *The Lone Ranger* and *The Green Hornet* .

The third major radio network came about through a court-ordered divestiture of one of NBC's dual networks in 1941. The network began when Edward J. Noble, of Life Savers candy fame, bought what was called NBC's Blue Network (which was created in 1927). It was eventually named the American Broadcasting Company (ABC) and could rightfully boast of being the second oldest network in the country.

Broadcast Radio Soars: Regulation Keeps It from Flying Apart

As the networks prospered in what would become known as radio's Golden Age — the 1920's, 1930's and the first half of the 1940's — there were repeated calls from both inside and outside the industry to regulate this new mass media. The hands-off political attitude of the early 1900's and the pre-Depression 1920's produced a couple of largely ineffective pieces of legislation as far as broadcast radio was concerned.

The Radio Act of 1912 established some general rules for radio or wireless transmission, but not necessarily for broadcasting. Basically, it mandated federal licensing of all land transmitters, with very few, if any, restrictions on who got a license. As a result of this largely unchecked licensing, the growing number of operators in the early 1920's produced chaos on the airwaves.

When Herbert Hoover became Secretary of Commerce in 1921, he tried to bring some order to the situation by ordering station operators to share time on the same channel. The sheer volume of new stations coming on the air quickly shattered what little calm that order had tried to establish. Soon, station owners were changing their frequency, operating times, power and their locations almost at will to try to beat the interference from other broadcasters.

By 1926, the situation had become so intolerable that even the broadcasters were demanding that the government step in and do something. The result was the Radio Act of 1927. The Act established the Federal Radio Commission (FRC), at first on a temporary basis and then permanently. The FRC was given the power to clearly define the broadcast band with standardized channel designations. It also shut down portable transmitters and regulated the number of radio stations that were allowed to broadcast at night. This management by the FRC brought, for the first time, a good measure of stability to a new industry that had never really had any regulation.

The most comprehensive regulation of radio broadcasting and communications in general was finally set into place with the passage of the Communications Act of 1934. The Act was a cooperative effort , based on an exhaustive study by Congress and by President Franklin Roosevelt's belief that the overlapping jurisdictions of a number of agencies dealing with various aspects of communications should be handled by a single entity. While incorporating large sections of the Radio Act of 1927, the new legislation did establish the Federal Communications Commission (FCC) as a stronger successor to the FRC.

Broadcast Radio: The Tie That Binds in Troubled Times

The true value of broadcast radio was probably never fully appreciated until its most important days were long past. Timing is everything, and radio's quick development in the 1920's was perfectly timed for the hard days that followed in the 1930's and during World War II.

The wrenching wound left by the stock market crash of 1929 could very well have destroyed the country. The very foundations of American democracy were shaken and many, many people were seriously questioning the basic economic tenets upon which the country was founded. With all the suffering that was experienced during the Great Depression, it's important to consider what might have happened if radio had not been available.

Basically, radio helped keep a disheartened populace in touch with itself. In fact, a good part of President Franklin Roosevelt's initial success came from his innate abilities to use the power of broadcast radio to talk the American public through one of the worst times in the country's political history . Whether one agreed with his politics or not, his famous fireside chats gave the public a sense of instant community and purpose that was impossible in any other media of the day. His first chat was broadcast on March 12, 1933, and drew an estimated audience of 60 million people.

Radio Brings Laughter and Tears to American Homes
Yet, according to some, one of broadcast radio's most enduring legacies during this Golden Age was not really associated with its role as a dispenser of news or as an observer of historical events. For a people, many of whom had had their spirits broken, radio's power was in its ability to entertain, to take their minds off the grinding reality they faced day in and day out.

In doing so, broadcast radio laid vital groundwork for a new medium — television — that would revolutionize the world in just a few short decades. In fact, the types of programs, shows and talent developed by broadcast radio in the 1930's and 1940's served as a virtual blueprint for what television broadcast in the late 1940's and throughout the 1950's.

One show, more than any other, typified the importance people attached to radio during the troubled days of the depression. In the early 1930's, the *Amos Ôn' Andy* situation comedy burst upon the network broadcasting scene, running 5 days a week for 15 minutes each episode. Despite all its negatives by today's standards, this show and many others provided what a disillusioned populace needed more than anything else — laughter. Reportedly, traffic stopped in many communities when *Amos Ôn' Andy* was broadcast so people could pull over to tune in the show. To keep customers coming to the movies, many theaters stopped whatever was showing at 7:00 p.m. to pipe in the 15-minute radio broadcast.

Many of the radio shows and stars that captivated the American public's attention and imagination during 1930's and 1940's became cross-media hits. Whether their popularity translated into additional recording hits, movie features or eventually to television, it was broadcast radio that served as the core of their popularity and success with the public.

Comedians like Jack Benny, Eddie Cantor, Bob Hope, George Burns and Gracie Allen, Edgar Bergen and Charlie McCarthy, and Milton Berle; musicians like Tommy Dorsey, Duke Ellington, Benny Goodman, Harry James and Glenn Miller; singers like Bing Crosby, Frank Sinatra and Kate Smith; and shows like *The Lone Ranger*, *Superman*, and *The Guiding Light* established their popularity in broadcast radio and then went on to other media to expand and extend their success.

Broadcast radio also served a vital role in World War II. It was through radio that the American public was able to follow the greatest conflict of the twentieth century .

Live overseas news reports, inaugurated during Hitler's showdown over the Munich crisis of 1938, brought pre-war tensions into American homes from coast to coast. CBS, as the first network to set up a cadre of overseas correspondents during the war, was particularly successful in establishing itself as a leader in radio news broadcasting. This leadership role would transfer to television and last well into the 1980's. And, although there were severe wartime restrictions on the production of transmitting equipment, radio receivers and station construction, the number of on-air stations more than doubled, to more than 1,000, by 1946.

Television Takes Off: Broadcast Radio Struggles

With the end of World War II, great changes came about in almost every facet of American life. Broadcast radio wasn't exempt. In fact, the advent of broadcast television as an entertainment force in 1948 was thought by many to be a death knell for radio. Broadcast radio's predicted demise proved to be wrong, however.

The wholesale looting of radio's programming and talent by television in the late 1940's would prove to be the end of full-service network programming on broadcast radio. This almost overnight conversion of shows, sponsors and stars was perpetrated by network leaders themselves. William Paley at CBS was one of the most successful when he raided NBC radio in 1948 and signed such stars as Jack Benny, Bing Crosby, Red Skelton, George Burns and Gracie Allen, Edgar Bergen, Groucho Marx and Frank Sinatra.

How did he do it? Paley came up with an ingenious plan that helped the stars to incorporate themselves and then sell their corporation's services, that is, the star's performances and talent, to the network in lieu of a traditional salary. The advantage? The performers could reduce their tax liability from as high as 77 percent to as little as 25 percent. These stars, once in the CBS camp, largely stayed there and made a seamless jump to CBS television.

By the late 1950's broadcast radio's network system had essentially been gutted by the flight of talent to television. The knockout punch came when a growing number of radio stations around the country started refusing to continue their network affiliations.

The bottom-line figures told the story even more dramatically. By 1958, the total income of radio stations had dropped from $46 million in 1948 to just $41 million. That in itself was not overly alarming. But, the fact that twice as many stations were dividing up that total was a problem. In essence, stations in 1958, on average, were earning just half of what they had earned ten years earlier.

Rock and Roll Rescues Broadcast Radio

The resurrection of much of broadcast radio came about from one of its first programming successes — music. But, this particular brand of music, a strange new sound called rock and roll, was like no other . And the format that it was eventually packaged in, top-40 radio, was something new to listeners.

Loud, abrasive and incredibly fast, top-40 radio captured a whole new generation of listeners (while repelling scores of other listeners). This innovation in programming often turned station fortunes around in a matter of weeks or months. It also signaled that radio's post-war path to success was to be found in niche broadcasting.

Stations scrambled to find the right formula that would appeal to the most listeners. Whether it was top-40, golden oldies, news, sports, classical or talk radio, AM stations carved out their piece of the market by narrowing their appeal and focusing and fine-tuning their programming.

The new reality for those who continued their network affiliations was even worse. In 1948, radio networks and their owned and operated stations (o&o's) earned a respectable $18 million. Just a decade later, that income was down to zero as demand for radio network programming plummeted. Eventually, the networks scaled their offerings back to include regularly scheduled news updates and reports, special informational features, some public affairs shows and live sporting events.

Radio Networks Respond to a New Reality

The ABC radio network led the way in dealing with the new realities of the fragmented, niche programming that dominates radio today. In 1968, the network addressed the audience segmentation of its affiliates by designing four services (or mini-networks) aimed at specific audience types that listened to the four most popular formats.

These services included regularly scheduled newscasts and entertainment updates of varying lengths and depth, depending on the specific demographics of the audience being targeted by a particular affiliate. The wide success ABC had with this approach encouraged it to expand the original four services to seven. And, nearly 20 years after the fact, affiliate pressures at CBS and NBC forced those networks to offer similar services.

Yet even with these changes, network affiliation arrangements are no longer as profitable as they once were. Today, network programming makes up less than 10 percent of the total ad revenues earned by broadcast radio.

FM Takes Its Place in the Broadcast Lineup

The post-war era also saw the emergence and triumph of FM broadcasting from near total obscurity. Developed in 1933, the superior quality of FM broadcast signals was essentially ignored for nearly 30 years. In large part, this was due to the lack of available receiver technology. This neglect of the FM band eventually took its toll on its inventor, Edwin Armstrong. Despairing about FM's lack of success, he committed suicide in 1954.

Essentially, the problem was that FM was ahead of its time. Its turnaround in the late 1950's and early 1960's came about with increasing listener sophistication that demanded better quality sound, the saturation of the AM band and a policy of encouragement from the FCC.

The stage was set in 1961, when the FCC created standards for FM stereo broadcasting. This, in turn, spurred public interest in better quality sound and encouraged manufacturers to produce the FM stereo receivers the public began demanding.

Then, between 1965 and 1967, the FCC formulated and enforced its nonduplication rule, which required major market AM/FM owners to come up with independent FM programming at least 50 percent of the time. This helped halt the practice of simply carrying AM programs on sister FM channels, which had typified much of what little FM broadcasting there was at this time. Eventually, the rule was widened to include smaller markets and a larger percentage of an FM station's broadcasting time.

The increasing market demand for FM stereo compelled radio manufacturers to add the band to nearly all radios by 1974. Just a few years later, FM radios were available in most new cars, as well. Today, it's highly unusual to see a late model car without an AM/FM radio.

Broadcast Radio Still Packs a Wallop

It was broadcast radio that helped get Americans where they are today in communications. As the first true electronic mass media, it helped shape all that would follow. The programs we see on network and cable TV today can trace their lineage back to those early radio broadcasts that sought to cheer up devastated families during the Great Depression.

The advertisers and sponsors who fuel television's growth (and probably that of the information superhighway) in the future take their cue from the ads that first ran on radio in the 1920's. And, the regulations that keep the airwaves open — whether for radio, TV, cable, microwave and satellite transmissions, or cellular phones — got their start when broadcast radio ignited the public's passion for instant communication.

As far as legacies go, few technologies can match that of broadcast radio.

u contributed by Michael C. Lafferty

Broadcast Radio: How It Works

While radio broadcasting may seem a relatively new development in humanity's overall evolution, it's based on a basic force of nature that's been around since the beginning of time — electromagnetism. By tapping into that force — to reshape it, control it and direct it — with an array of converters, transmitters and receivers, humanity has been able to transmit sound, and then pictures, without being tied down by expensive, cumbersome, land-based communication systems.

Radio Waves: A Fundamental Force

There are four fundamental forces in nature. Two deal with the relationships of atomic and sub-atomic particles. A third, gravity, is more familiar to most people. The fourth, electromagnetism, while somewhat more obscure to the typical person on the street, is no less important. It's what makes radio and all other forms of wireless communications possible.

Simply put, electromagnetism is based on two concepts: electric currents produce magnetic fields; and changing magnetic fields produce electric fields. These electric and magnetic forces, in turn, produce an oscillation (a back and forth movement) of electric charges. These oscillations occur in a predictable pattern as electromagnetic waves that fluctuate with alternating peaks and troughs. The measured distance from the crest of one wave to the crest of the next wave is the wavelength of that particular electromagnetic wave.

The electromagnetic spectrum is made up of bands of different wavelengths, most of which are invisible. These include (from shortest to longest wavelength) gamma rays, x rays, ultraviolet light, visible light, infrared rays and radio waves. These waves also have distinctive frequencies, that is, the total number of individual wavelike motions (cycles) produced each second, which are measured in Hertz (Hz).

Electromagnetic waves in the spectrum run from the shortest wavelengths imaginable (gamma rays have a wavelength less than 1 trillionth of a meter in length with a 100 sextillion Hertz frequency), to some fairly substantial wavelengths (some radio waves have wavelengths of more than 6,200 miles). The most common units of frequency when talking about waves in the radio band include kilohertz (kHz / thousands), megahertz (MHz / millions) and gigahertz (GHz / billions). Radio waves can be found on the lower frequency/longer wavelength end of the spectrum, running (relatively) from extremely high (300 gigahertz) to extremely low (30 hertz) frequencies.

The Sound of Music, Man and Machines…

Radio waves are one thing and sound is something else, even though they do share some characteristics. Both have to be present to make radio and other forms of wireless communications worthwhile.

Like radio waves, sound originates as vibrations or oscillations. In the case of human speech, it's the vibrating vocal cords of the speaker that are setting molecules of air into a wavelike motion. These sound waves travel through the air to an interested listener's eardrum. That listener's eardrum receives and duplicates those vibrations, thereby stimulating nerve endings leading to his/her brain. Those signals are then interpreted by the brain as specific words and phrases.

However, there are essential differences between sound waves and radio waves that should be remembered. Physical limitations of the human ear restrict audible sound to about 20 - 20,000 cycles per second (cps) frequency. Yet radio waves run from just a few cycles per second into the billions.

Also, radio waves also travel at the speed of light (186,000 mph), which is nearly 900,000 times the speed of sound in air. Additionally, unlike radio waves which travel well in a vacuum, a sound wave must have some sort of conductor like air or water to move from its point of origin to a recipient. This is why the term *airwave* often used for radio waves, is not technically correct.

Making Sounds Electric
Before any radio broadcasts or wireless communications can take place, the sounds to be transmitted (whether from a conversation, a symphony orchestra or a major sporting event) must be converted into an electric radio signal.

The key tool here is the common, everyday microphone. Generally there are two types of microphones: a dynamic or moving coil microphone and a capacitor or condenser microphone. For the sake of this discussion, the moving coil type will suffice.

Underneath its wire mesh dome, the moving coil microphone has a small, delicate disk or diaphragm that is, in turn, attached to a wire coil. The diaphragm vibrates at the same frequency or speed as the incoming sounds. The oscillating disk then transfers its vibrations to the coil whose base is situated near a magnet. It's this movement of the coil near the magnet that produces an electric current.

This newly formed electric current, based on the specific vibrations of the sounds being fed into the microphone, becomes the electrical sound signal as it begins its broadcast journey.

Joining Forces
Sound signals by themselves are not strong enough to be transmitted any great distance. The transmission of sound is accomplished by piggy-backing the audio signal onto a continuous carrier wave through a process called modulation. There are two ways to accomplish this task, either through amplitude modulation (AM) or frequency modulation (FM).

Amplitude modulation is the most common. In this process, the high frequency carrier wave has its amplitude (or intensity) altered to mimic the amplitude pattern of the sound wave it's carrying. Because the stronger carrier wave is made to duplicate the sound signal's highs and lows in amplitude, the combined AM wave is more prone to interference as it stretches the limits of its amplitude range. Generally, low (30 - 300 kHz), medium (300 kHz - 3 MHz) and high (3 - 30 MHz) frequency radio waves are amplitude modulated.

Frequency modulation, however, is not plagued by such interference. That's because its amplitude remains constant. Instead, the carrier wave's frequency is modulated or changed to match the pattern of the audio wave it is carrying. As the audio signal continuously fluctuates or oscillates from strong to weak and back again, the carrier wave's frequency increases or decreases accordingly. As a rule, very high frequencies (30 - 300 MHz) are frequency modulated.

When radio broadcasting first began, it soon became clear that a certain amount of regulation was needed to prevent the airwaves from turning into a jumbled mess of conflicting signals. Worldwide efforts at establishing some sort of regulatory structure on wire and eventually wireless communications began in 1865 when 25 European countries composed and ratified the International Telegraphic Convention. This served as the basis for the International Telecommunications Union (ITU) which establishes broad parameters for communications worldwide through its offices at the United Nations.

In the United States, ITU guidelines and more specific regulations, such as assignment of call letters, licensing of radio and television stations and myriad associated policies and rules are enforced by the Federal Communications Commission (FCC). The FCC was established by President Roosevelt's Communications Act of 1934 in order to consolidate all electronic communications policy and regulation into one agency.

The AM broadcasting band in the United States runs from 535 to 1,705 kHz (expanded from 1,605 kHz in 1988), creating a total bandwidth of 1,170 kHz. To avoid adjacent- or co-channel interference, the FCC establishes geographic and channel width parameters. AM channels in the United States are spaced 10 kHz apart which allows for a 5-kHz extension above and below a station's carrier frequency.

FM channels in the United States occupy a 20-MHz band, running from 88 to 108 MHz. To prevent overlapping signals, the FCC stipulates a 200 kHz bandwidth for FM channels. This expanded channel width is dictated in part by the greater number of frequencies used in frequency modulation.

The basic components of a transmitter include an oscillator, a modulator and a radio frequency (RF) amplifier. The oscillator produces the carrier wave. The modulator puts the carrier wave and the sound signal together, and the amplifier strengthens the modulated waves for transmission.

The process is slightly different for stereo signals. In 1961, the FCC made a ruling that allowed FM stations to broadcast in stereo by adding a second carrier wave to provide stereophonic sound. But, the FCC also insisted that the FM station's signal must be compatible with FM receivers that didn't have the stereo option.

At the sound's source, two sets of equipment are used to pick up and amplify two versions of the same sound, much like a person's right and left ear do naturally. One version of the sound signal, combining both the left and right feeds from the sound source is transmitted over the main FM carrier wave. This is the signal that would be processed and heard by receivers that have "mono" reproduction capabilities.

At the same time, the transmitter also sends out another version of the "mono" signal that has either the left or right channel subtracted from it. This second signal is modulated and carried on a specially created subcarrier wave. Using a variety of circuits, the stereo receiver then separates and amplifies the two signals (both the combined "mono" signal and the altered subcarrier wave signal), then generates separate right and left channels which are then further amplified and channeled into the appropriate speakers.

Up, Up and Away
When radio was in its early infancy, many naysayers scoffed at the idea of long-distance wireless communications. In an updated version of the "Earth-is-flat" argument of Columbus' day, these skeptics believed radio's future and its ability to transmit signals went about as far as the eye could see, that is, to the horizon.

While their dire predictions failed to materialize, they did contain a kernel of truth. That's because the distance a radio wave may travel depends on a number of factors including its frequency, wavelength, transmission power and even the surrounding terrain. Not too surprising, radio energy grows weaker as it moves farther from its point of origin. Additionally, higher frequency/shorter wavelength (FM) radio waves are more readily absorbed by the atmosphere. Therefore, they tend to not to travel as far as low frequency/long wavelength (AM) radio waves.

To work effectively, antennas used for transmitting signals, especially AM waves, are built to achieve a mathematical proportion that optimizes coverage. As such, transmitting antenna are usually one-quarter to one-half the size of the wavelength they're radiating. At the lower end of the AM spectrum (for example, 540 kHz) the transmitting antenna would be slightly over 1,800 feet. At the higher end of the AM band (for example, 1,600 kHz) antennas reach to just under 600 feet.

A common antenna, a vertical dipole, illustrates how many radiating antennas work. This particular antenna is not grounded and is half the length of the wave it's radiating. An oscillating voltage is sent to the gap at the antenna's center. The first pulse sends a positive charge to the top of the antenna, while the antenna's bottom section receives a negative charge. This creates an electric field between the two sections of the antenna.

Immediately, a second pulse reverses the polarity of the antenna. The new electric field produced by the second pulse repels the first field, sending it out into space. This movement of the alternating electric fields creates magnetic fields as well. The moving electric and magnetic fields combine together to create a unique form of energy, the electromagnetic (radio) wave.

If the polarity reversal is not done fast enough, the fields will collapse. Therefore, there is a minimum frequency threshold below which radiation will not take place. When an antenna is radiating at its peak frequency it is said to have reached its resonant frequency.

Antennas produce three types of broadcast waves: ground, direct and sky waves. Ground waves spread out through the air just above and through the Earth's surface, following its curvature for some distance beyond the horizon. Used mainly for medium frequency AM waves, ground waves are greatly affected by soil conditions. Radio energy can be severely hampered by older formations of rocks or dry, sandy soil. Damp soil or large bodies of water, however, conduct radio signals quite well.

Most FM stations, because of their high frequency, achieve their coverage based on direct or line-of-sight transmission. Since their coverage is restricted, depending on the surrounding terrain, they sometimes may use relay facilities to extend their reach. However, FM stations have another advantage over AM stations besides their clearer reception and sound quality. It's their transmitting power. The most powerful AM stations have a 50,000-watt limit. FM stations can be certified for up to 100,000 watts of power, which, given the right conditions, can extend their range up to nearly 65 miles.

Sky waves, as their name implies, head skyward. Depending on their frequency and wavelength, they may bounce off electrified particles in the ionosphere back down to Earth, extending a radio station's reach far beyond the horizon. The ionosphere is made up of a number of layers ranging from 40 to 600 miles above the earth. These layers are constantly moving due to the sun's heating and cooling influences on a daily and even seasonal basis.

The reflective properties of the ionosphere work best with high power, medium frequency AM waves or high frequency, short-wave radio bands. It's not unusual for radio stations to use this phenomenon to achieve more than one bounce down or reflection, which is called multihop propagation. However, sometimes a skip area or dead zone may be created between a station's ground wave coverage and its sky wave coverage where the signal cannot be heard.

As a result, most stations carefully engineer their antenna coverage based on the power of their transmitter and the geography of their broadcast area. Some stations may want to send out their signal equally in all directions with a variety of different antennas and antenna arrays. Or, they may concentrate their beams to avoid interference with other stations, to tailor their coverage to coincide with concentrated population centers, or to save power by avoiding transmission over large bodies of water. Stations also benefit from antenna gain by concentrating their radiated signal, which can boost their signal's effective strength quite substantially.

While higher frequency radio waves are less likely to be reflected by the ionosphere, with proper planning they can be refracted or bent back towards Earth. The key is to achieve the signal's critical angle. If the angle is too great, the signal shoots straight through the ionosphere into space. If the angle is too short, the signal will be simply absorbed by the ionosphere.

Tuning In

Wireless communication equipment has come a long way since the crude apparatus used by German physicist Heinrich Hertz in his groundbreaking radio wave research and Guglielmo Marconi's first radio telegraph. The progression of wireless technology in the first 100 years from vacuum tubes to transistors to integrated circuits and now to microchips has been breathtaking.

However, it's still possible to break down the basic technology of radio receivers into four easily understood units or circuits. Those units themselves are often made up of similar parts or components that can be individually defined by the various tasks they perform in any given circuit.

Following the order in which a radio signal is received and processed, the first component is the antenna. Depending on a radio's design, the antenna can consist of a wire buried in the inner workings of the radio itself, or it can be the conventional metal rod that is attached to the radio's exterior. Quite simply, radiated waves create electrical waves or currents, though very weak ones, in the radio antenna.

The tuner circuit allows the radio to narrow its focus on a specific frequency band for processing. The tuner's key device is a variable capacitor. This produces changes in the radio's circuits so that the radio is sensitive to a specific frequency.

Once the weak electric current of a specific frequency has been isolated by the tuner, that signal must be separated from its carrier wave and have its audio signal strength boosted before it reaches the speaker. All this is accomplished by what is called the superheterodyne circuit.

This circuit accomplishes those tasks through four basic components: a converter, an intermediate-frequency (IF) amplifier, a detector and an audio-frequency (AF) amplifier. The converter transforms the weak radiated signal to a lower frequency that is then sent through one or more IF amplifiers to give it strength. At this point, the detector separates the carrier wave from the audio frequency or signal. From here the signal goes through one or more AF amplifiers for final strengthening before it reaches the loudspeaker.

The speaker acts much like the microphone, but in reverse. It too consists of a magnet and a wire coil called the voice coil. This coil is attached to the speaker cone which is usually made of paper or plastic. The amplified electric waves go through the coil and produce vibrations against the magnet's field. These vibrations in the cone recreate the sounds first picked up by the microphone just milliseconds before in the radio studio.

These general circuits contain various components that perform specific functions to assist in the processing of the radiated waves. A good deal of a radio's internal operations deal with converting and controlling the radio's 60 Hz alternating current (AC) supplied from a wall outlet into the direct current (DC) the radio needs to operate. These components include:

Resistors: As one of the simplest components in a radio, a resistor's main job is to restrict, not stop, electron flow. Some resistors can have their resistance adjusted as needed. A good example is the resistor found in volume control circuits. As the resistance increases, restricting electron flow more and more, the radio's sound decreases. In reverse, as resistance is lessened, more and more electrons flow and the neighbors start complaining about all the noise.
Capacitors (which replaced condensers): These are basic electron storage devices used to direct and control AC and DC as needed for specific radio operations.
Inductors: Inductors operate somewhat differently than capacitors in that they generally block higher frequencies of AC, while letting the flow of DC and low-frequency AC continue unimpeded. The way inductors and capacitors react to different frequencies allows radios to filter out various unwanted radio frequencies and interference.
Semiconductors: Many, if not most, semiconductors are made of silicon which is essentially refined sand. The silicon is then treated with specific chemicals to make it either positive type (P-type) material or negative type (N-type) material. Various semiconductors are produced using different combinations of the two silicon types.

A semiconductor diode is made up of a piece of P-type material connected with a piece of N-type material. As the main component used to convert AC to DC, the diode totally blocks current flow in one direction, but allows it to pass in the other.

Semiconductor triodes, or transistors as they are commonly known, use three pieces of P- and N-type material. Depending on their specific job, these transistors can have a PNP configuration or a NPN arrangement. They have many uses, but are especially adept at amplifying. They take the weak signals received from the antenna and other components and amplify them thousands of times for final broadcast through the radio speaker(s).

A Fundamental Force with a Future

Few technologies have revolutionized the world like the radio. The underlying concepts and scientific theories that make radio, or wireless communications, possible have not only played a major part in 20th century history, but they've also actually had a hand in shaping humanity's destiny during this frenzied millennium.

And, the concepts that made radio what it was and is today will continue to have a significant impact on generations far into the future. The ability to communicate over vast distances, around the world and even far into space without physical contact or connection is absolutely essential not only to humanity's growth and development, but its survival as well.

u contributed by Michael C. Lafferty

Broadcast Radio Industry

With the advent of broadcast television in the late 1940's, the broadcast radio industry underwent fundamental change. In just a few years time, Americans no longer listened to their radios for the latest news; they switched on their TVs instead. They no longer sat in front of their radios for family entertainment; they gathered to watch the boob tube. Many knowledgeable people, both in and out of the industry, predicted the end of radio. But the thousands of stations scattered around the country had something else in mind. They began to reinvent themselves. As a result, the industry expanded and diversified. Today, it's a vibrant media generating nearly $8 billion annually in advertising revenues. Obviously, the news of radio's death was greatly exaggerated.

The Transformation of Broadcast Radio

The wholesale raiding of radio's talented performers and writers, program formats and advertisers by the newborn television industry in the late 1940's and the 1950's essentially gutted broadcast radio as it was then known. The knockout punch came when a growing number of radio stations around the country started refusing to continue their network affiliations.

The bottom-line figures told the story even more dramatically. The total income of radio stations had dropped from $46 million in 1948 to just $41 million ten years later. That in itself was not overly alarming. But, the fact that twice as many stations were dividing up that total was a problem. In essence, stations in 1958, on average, were earning just half of what they had earned in 1948.

Rock Revives Ailing Radio

Yet, the seeds of radio's revival and transformation were rooted firmly in two distinct phenomena of the 1950's. Rock and roll not only shook up teens and their parents nationwide, it also rattled and revitalized the ailing radio industry down to its very roots . At the same time, the increasingly affluent war veterans were getting their piece of the American Dream. And, a big part of that dream was not only a house with a white picket fence, but also a brand, spanking new car with, of course, a radio.

Rock and roll gained national recognition in the early 1950's through Cleveland disc jockey (DJ) Alan Freed . The crossover power of this raucous music appealed to both black and white audiences, to rural and city audiences, to audiences in the north, south, east and west.

Packaging this new sound into a radio-friendly format reportedly came about through the efforts of two different station owners, Gordon McLendon and Todd Storz. According to radio legend, the Top 40 format got its start when Storz saw people playing the same songs on a jukebox over and over.

Storz developed a broadcasting formula that capitalized on that repetitive behavior and took on a personality much like the music itself…fast, loud and brash. For the increasingly mobile teens of the 1950's, with their low-riding cars and their high-volume radios, it was a perfect match. In the late 1950's, a one-hour slot on a Storz Top 40 station yielded the following: 125 program items, 73 brief announcements on weather and promotional items, 58 call letter announcements and a 3-1/2 minute newscast with no news item earning more than two sentences of copy.

Realizing that even rock and roll had audience limitations, American broadcasters started developing other niche formats for radio. In fact, the process of developing individual formats for radio stations turned into a recognized profession within the broadcast radio industry.

More and more stations scrambled to find the formula that would appeal to the most listeners. Whether it was Top 40, golden oldies, news, sports, classical or talk radio, individual AM stations carved out their piece of the market by narrowing their appeal and focusing and fine-tuning their programming.

Technology Takes Radio to a New Level

The post-war era also saw the emergence and triumph of FM broadcasting from near total obscurity. Developed in 1933, the superior, static-free quality of FM broadcast signals was essentially ignored for nearly 30 years. In large part, this was due to the lack of available receiver technology in the market.

Essentially, the problem was that FM was ahead of its time. The stage was set for its emergence in 1961, however, when the FCC promulgated standards for FM stereo broadcasting. This, in turn, spurred interest in the public for better quality sound. The increasing market demand for FM stereo compelled radio manufacturers to add the band to nearly all radios by 1974. Just a few years later, FM radios were also available in most new cars. By the late 1970's, FM had surpassed AM in popularity, and by the late 1980's, it boasted three listeners for every one AM listener.

With the introduction of increasingly sophisticated equipment during the last two decades, many stations, both AM and FM, are getting their complete format via satellite or on tape from networks or radio format syndicators. In fact, it's not unusual to find some stations that are largely, if not totally, automated.

Here's how it usually works. The bigger networks or syndicators usually provide music in a full 24-hour format, although some smaller companies produce programs just several hours in length. Then, if needed, the local station will arrange an affiliation with a national network for newscasts that fit its audience's particular profile (see below). The radio station's sales staff is then able to concentrate its efforts on filling up the rest of the broadcasting time with local advertising commercials.

There are a number of music networks and syndicators in the industry. Most, if not all, of the bigger companies provide a wide variety of formats. These formats can range from several variations of rock, to a few country formats, to an easy listening format and possibly a classical format. Some of the formats are so finely tuned that they vary according to the seasons, for example, spring/summer selections are more upbeat, while fall/winter music is more laid-back and romantic.

One of the biggest syndicators in the business, Broadcast Programming, Inc. in Seattle, Washington, offers a full range of radio formats on tape and compact disc (CD). Some of the better-known satellite music networks include: Westwood One (which also owns

Mutual Broadcasting and the former NBC radio network stations), ABC/Satellite Music Network and Jones Satellite Networks. The latter offers more than a half-dozen specific formats, including FM Lite, Good Time Oldies, Z Spanish (a Spanish-language music format), The Team (an all-sports format), two adult contemporary formats and two country formats, one of which is the largest country and western network in the nation.

National Radio Networks Follow Affiliates' Lead

While stations around the country were experimenting with new music formats in the 1950's and 1960's, the once powerful national radio networks underwent their own transformation. Instead of leading the way in programming, the top three networks found themselves playing catch-up with their affiliates.

The American Broadcasting Company (ABC) radio network led the way in dealing with the new realities of the fragmented, niche programming that dominates radio today. In 1968, the network addressed the audience segmentation of its affiliates by designing four services (or mini networks) aimed at specific audience types that listened to the four most popular formats.

These services provided regularly scheduled newscasts and entertainment updates of varying lengths and depth, depending on the specific demographics of the audience being targeted by a particular affiliate. ABC's Rock Radio, for example, provides one-minute newscasts on the entertainment world targeted to 18- to 24-year-olds. ABC's Contemporary Network offers one-minute news summaries on a wide range of topics aimed at a larger audience, while its information service produces five-minute newscasts that are intended for all-news or news/talk station formats.

ABC's wide success with this approach encouraged expansion from the original four services to seven. And, nearly 20 years after the fact, affiliate pressures at CBS and NBC forced those networks to offer similar services. Westwood One's Mutual Broadcasting System, for example, provides nearly 800 of its 2,000 affiliates with five-minute newscasts on the hour and the half hour, as well as one-minute headline news updates twice an hour at 25 and 55 minutes past the hour.

Talk and sports shows are other areas where national networks thrive. ABC has Talkradio and NBC has TalkNet to supply overnight talk and interview shows. These programs are supplied primarily to AM stations in major markets across the United States. Mutual Broadcasting has a long-standing hit in this area with *Larry King Live* (l-r: Larry King, Ross Perot), which preceded his clone TV hit on cable television's CNN. Mutual now distributes a radio simulcast of King's CNN television show to nearly 1,000 radio affiliates nationwide.

Mutual also has a big stake in sports broadcasting, where it has claimed the rights to national collegiate football games for nearly 30 years and also has rights to air professional football on Sundays. Coverage of many college and professional games is provided by regional networks as well. The value the networks place on sports broadcasting is evidenced by the fact that CBS paid $50 million for the radio rights to professional baseball games in the early 1990's.

Radio Networks & Syndicators: Two Distinct Program Resources

Many local stations affiliate with one network that provides news and/or sports and with another network that supplies music. While networks that supply music are not as numerous, those that do, such as ABC/Satellite Music Network, Jones Satellite Networks and Westwood One, each have around 1,000 affiliates. *Casey Kasem's Top 40*, now on Westwood One after 20 years on ABC, is one of the best-known syndicated music shows on broadcast radio.

As economical satellite transmission of programming spread throughout the industry in the 1970's, a number of new networks sprang up to take advantage of the technology. By 1990, nearly 20 national radio networks were battling for affiliates throughout the country.

While networks and format syndicators are difficult to tell apart just by listening to them, there are clear distinctions. Networks specialize in providing (by satellite) all-music or all-talk programming, news and/or sports coverage and special features on a barter basis that centers around an agreed amount of time dedicated to national advertising. The networks and the local affiliate then negotiate how much advertising time can be sold locally. Some networks pay affiliates in major markets to carry their programs.

Syndicators, however, aren't involved in either news or sports programming. Instead, they supply (either on tape or CD) specifically formatted music programming (usually on a 24-hour basis) interspersed with appropriate music-related features and specific gaps for local advertising and local or network newscasts. As a rule, syndicators operate on a simple cash/fee basis for their programs. However, in some rare cases, they provide programming at little or no cost to stations in large markets to ensure a wider reach and higher syndication rates in other markets for their shows.

Broadcast Radio Formats: Markets within Markets within Markets…

Niche marketing, which has become a business buzz word in the 1990's, got a good start when radio stations started scrambling to survive in the 1950's and 1960's. By tailoring their broadcast approach to a specific audience, radio stations were able to survive and eventually flourish.

As a result, the ability to define an audience and the programming that will appeal to that audience has become a science and a profession in itself. This continual splitting of audience hairs has a produced a dizzying list of radio formats. For the lay person, sometimes the demographic distinctions are hardly noticeable between, say, an adult contemporary and contemporary hit radio audience. Yet, the determining factor is the marketplace itself. If two stations in a particular area can succeed by serving two segments of an audience, however marginally different, then they are indeed viable niche markets.

In general, today's radio programming formats fall into three general categories — information, religious and music. Informational programming can be broken down into four stand-alone subcategories of talk, news, education and agriculture. Together, these four subcategories are aired on less than 10 percent of the nation's radio stations.

Talk radio, with its focus on interviews and two-way telephone conversations and debates between radio hosts and listeners, has become a relatively big AM success with older, usually more conservative audiences. However, talk radio directors must often be on guard against dedicated repeat callers who voice extremist views that can drive advertisers away.

The mirror image of talk radio is *shock radio*, which usually takes delight in ridiculing long held traditions and poking fun at conservative public figures and policies. Not surprisingly, this calculated approach to outrage is designed to appeal to younger audiences, usually in major markets.

The *all-news* format usually provides hard news for only about 25 percent of the time; the rest is devoted to broader features and informational services. This format is based in major markets with large numbers of people, part of whom will tune in for 20 minutes at a time to catch the latest headlines, weather and driving conditions. Recent variants of this format, again usually found only in major markets, include *all-business* and *all-sports* stations.

Educational radio all but disappeared with the expansion of television in the 1950's and the more recent advent of videocassettes. Only about 2 percent of the nation's radio stations, usually non-commercial FM stations, provide educational programming. *Agricultural radio* provides important services and information for large and small producers alike, almost always through commercial AM stations in the Midwest.

Religious programming, or at least the selling of commercial time to religious program promoters, is still a controversial topic for many broadcasters. But, it's also a multimillion dollar business that accounts for about 8 percent of the nation's radio stations. These stations usually provide fundamentalist preaching accompanied by religious music. For those stations that offer religious music as the programming mainstay, more often than not on the AM band, there are recognized formats such as *contemporary Christian*, *Christian rock*, *Christian country* and *traditional gospel*.

Radio Music Formats: The More the Merrier

Today, however, mainstream music is where most radio programming diversity resides. *Country and western* (C&W) music, as a general format, is played on more stations than any other type of music. Broadcast from nearly 20 percent of all stations, C&W itself is being split into even more highly defined formats including urban, oldies, hot contemporary, mainstream contemporary and other special niches.

Yet, when it comes to more listeners, the wide-ranging rock category comes out on top. Under the rock umbrella are a wide variety of highly defined formats, some of which are more popular on AM, while others lend themselves better to FM broadcast stations. *Adult contemporary* (AC), however, is one format that seems to do well on either AM or FM. The AC format is designed to appeal to a relatively wide adult audience with a fairly large array of popular music and a big dose of golden oldies.

Contemporary hit radio (CHR) and *Top 40* are similar in that they stick to specific playlists of current hits that appeal more to teens and young adults. While CHR draws on a larger list, usually the most popular top 100 songs, both it and the Top 40 format can usually be found on the FM band. *Album-oriented rock* (AOR) has a strong appeal to males, largely on the FM band, with a mix of secondary hits from very popular albums and classic rock hits. AOR has lost some of its popularity to the *oldies* or *classic rock* formats, which focus on rock hits from the 1950's and 1960's. The broader approach of the oldies format is geared to appeal to adult baby boomers, primarily on the AM band, while the more recent classic rock format is touted as an FM format aimed at adult women.

Urban contemporary is a mix of rock and jazz aimed at blacks in major markets, while the *black* format is a combination of music and information geared to smaller, usually rural markets. Other large-market formats, primarily on FM, include the *beautiful music* and *easy listening* formats, which concentrate on instrumentals or orchestrated music mixed with popular songs. On the AM band in major metropolitan areas and mid-sized cities, the *big band/nostalgia* format, with its focus on big band music from the 1940's, is particularly popular.

Some formats tend to have smaller, more devoted audiences, usually on non-commercial stations. These formats, which are often found on the FM band, include *jazz*, *classical music* and *progressive*. The progressive format is a variant of rock with a focus on secondary hits from popular albums combined with more avant-garde rock cuts.

Radio's Future: Preserving the Status Quo
Despite the upheaval and the dire predictions of doom that the broadcast radio industry faced when television burst upon the scene in the 1950's, the industry finds itself in an enviable position today. More than 12,000 radio stations dot the landscape. America's high-speed, fast track lifestyle has conditioned the listening public to expect radio to provide an almost constant level of background music and information in the car, at work, in the home or on the beach.

Radio technology continues to advance, often leading the way for other electronic communication industries. While AM stereo is feasible and a number of broadcast systems have been developed and tried, the FCC's reluctance to pick one universal system, as it did with FM stereo broadcasting, has all but stopped further development in its tracks.

However, being the public media that it is, radio rarely escapes public scrutiny. Debates over broadcaster responsibilities concerning the content of the information radio disseminates (talk and shock radio) and the impact of the music radio plays (heavy metal and gangsta rap), will continue. Yet, given the growing reluctance of lawmakers to ride legislative herd over any of the communication industries, it seems that any and all changes in these areas will have to be generated within the industry itself.

u contributed by Michael C. Lafferty

Multimedia Networking

Using networks, such as cable systems, LANs and the Internet, to transmit multimedia documents.

Multimedia applications, such as games or instructional materials that combine elements including text, sound, graphics and video on CD-ROMs, are primarily used by individuals on stand-alone personal computers (PCs). However, it is also possible to distribute multimedia titles and documents through computers that are linked together. Such distribution of multimedia applications is referred to as networked multimedia, or multimedia networking.

Multimedia documents can be transmitted over any network that is capable of carrying multiple forms of information, such as voice, text, and graphics. These networks can range from local area networks (LANs), which primarily use cables to link computers in close proximity to one another, to wide area networks (WANs), which can cover large geographic areas by using a number of communications channels either alone or jointly. These channels can include telephone lines and microwave or satellite communications systems.

Although multimedia networking is still relatively new, the ways in which the technology is being used are rapidly expanding. Multimedia documents have long been used for educational instruction; now classroom computers can be linked to networks that deliver multimedia educational programs from a central server, eliminating the need for purchasing expensive CD-ROMs for each classroom. Businesses are increasingly looking toward multimedia networks for training personnel as well as for marketing new products and services to their customers. On-line networks, such as the Internet, already carry a number of documents with multimedia components; the World Wide Web, for example, brings together text, sound, images and other media that may be stored in many locations into single multimedia documents that can be accessed by using a web browser.

The data transmission capacities currently available on many networks can limit the types of multimedia documents that can be sent. Due to the digital technology used to create and store them, multimedia documents are large and memory intensive, making their transmission slow and cumbersome on existing telephone networks that are better equipped to transmit analog signals. Digital compression, which removes redundant or needless information from digital signals, is used to compress multimedia documents for both disk storage and faster transmission; however, the construction of new communications networks composed of the technology required for transmitting large digital documents will be necessary to support true real-time, interactive multimedia applications.

As transmission networks continue to expand and grow in their capacity for carrying information, the opportunities for transmitting multimedia documents through these networks will increase as well. Interactive multimedia titles will most likely become a part of the much-anticipated interactive entertainment and information services, including video on demand and interactive television, slated to become available to many homes in the United States by the turn of the century.

u contributed by Sonia Weiss

Broadcast Trends

As the first big steps along the information superhighway are taken in what's left of the twentieth century, the one descriptive word almost that everyone agrees sums up the future of communications is "convergence." While many argue how it may all come about, there's little disagreement that it will happen. That's because it's all coming together. Whether it's the latest technology in broadcast or cable TV, more powerful computers, advances in wireless or satellite communications, digital video/audio processing and compression — they're all merging. Meanwhile, this unprecedented convergence of technology is producing a whole new round of discussion and debate on what, if any, regulation will be needed to manage traffic on the superhighway. The discussion that follows deals with some of the trends in areas that are usually considered related to broadcasting, as it is known today. In the not-too-distant future, the lines that divide these trends from other fast-changing aspects of telecommunications will blur considerably, and may disappear all together.

Direct Broadcast Satellite (DBS): The Direct Approach Catches On...Finally
Like many emerging technologies, direct broadcast satellite (DBS) service was enthusiastically hailed when it was first announced in 1980 . This announcement followed the Federal Communications Commission's (FCC) 1979 decision to eliminate licensing requirements for television receive-only (TVRO) antennas. In effect, consumers finally had the right to own their own satellite receiving dishes.

The DBS concept was simple in the extreme. DBS would deliver programs directly to viewers, without either broadcast or cable system middlemen, via specially designed relay satellites and reception dishes. The execution, however, proved to be more of a hurdle than first expected.

By the time one of the first DBS systems had folded in 1985 due to excessive startup costs and lukewarm viewer response (only about 7,000 subscribers signed on), some of DBS's original proponents (Western Union, CBS and a Communications Satellite Corporation [COMSAT] subsidiary) decided to put their plans on hold. While DBS technology was impressive, its acceptance was hindered by the perception that it really had nothing new to offer in the way of programming services. That's because owners of the large (6 to 10 feet in diameter) dishes already on the market could capture most of the signals they wanted for free.

However, by the early 1990's a number of technological advances refocused attention and interest on DBS systems. Less expensive, lower powered satellites became available, as did smaller receiving dishes (1 to 3 feet in diameter) that operated in the higher powered Ku-band frequencies. Cable operators also developed new ways to scramble their signals. And, the Cable Act of 1992 helped prospective DBS operators by requiring that cable programmers, such as Cinemax and CNN, provide their services to any competing delivery system (like DBS) at similar prices.

As a result, two companies have gone head-to-head in the rejuvenated DBS competition and a third is on the way. DIRECTV has built a $100 million, state-of-the-art digital broadcast center in Castle Rock, Colorado, to process signals that are being fed to Digital Satellite System (DSS) equipment made by a consortium of General Motors' Hughes Electronics, RCA/Thomson and Hubbard Broadcasting. DIRECTV (a unit of Hughes Electronics) and United States Satellite Broadcasting (a subsidiary of Hubbard Broadcasting) are offering viewers a total of 175 channels through a pizza-sized dish (18 inches in diameter) produced by RCA.

Another DBS operator is PRIMESTAR, which is co-owned by General Electric and six cable operators. With the launching of a second satellite, PRIMESTAR is promising to provide more than 200 channels by mid-1996. A third competitor, EchoStar Communications, has planned a satellite launch for 1996 as well. Once it's up and running, EchoStar vows to relay up to 250 channels to homes nationwide.

While the rollouts of DIRECTV and PRIMESTAR have been promising (dishes have sold out in the 41 states where they've been marketed), their future is still in doubt. The core market for DBS services is the 10 to 12 million homes in rural America that do not have cable service. Of that total, nearly a third (approximately 3.6 million) already have the older (and larger) C-band dishes.

Although competitors in the cable industry like to point out that DBS will be unable to provide interactive services in the future, interactivity may be a double-edged sword for the cable industry. Consumer demand for the fully interactive 500-channel nirvana pictured by some cable executives has yet to be established, and there will be problems if the demand is less than expected. In addition, if the cost is too high or it takes too long to develop user-friendly technology consumers may look elsewhere for their home entertainment. (Current predictions forecast operational interactive services by the late 1990's at the earliest, after the turn of the century at the latest.) So, alternate telecommunication providers like DBS operators could reap the rewards of a failed or disappointing interactive reality.

In the meantime, with the federal regulations on cable rates expected to be eased, if not totally eliminated, DBS competition will more than likely restrain cable operators from going through the roof with new charges.

High Definition Television: The Big Picture Finally Comes Into Focus

The history of the development of high definition television (HDTV), at least in the United States, has been one of yawning indifference, renewed interest and finally, impressive innovation . America's initial indifference is due in part to the fact that the demand for movie theater quality TV has yet to be proved. In addition, the projected cost of the first HDTV systems (some estimate $5,000 or more per set) is another concern for electronic industry officials in the United States.

Such hesitancy didn't hamper competitors overseas. During the early 1980's, the Japanese targeted HDTV as a new market to conquer and began aggressive research and development in the area. The Europeans soon followed with their own HDTV research, in large part to fend off Japan's potential domination of this new consumer electronic gold mine.

The American consumer electronics industry, after being decimated by a flood of relatively cheap but high quality electronics (especially televisions) from Japan, finally decided to get in the HDTV act in the late 1980's. That was when the Federal Communications Commission (FCC) ruled that any high definition system adopted would have to be compatible with existing receivers, which operate on the National Television Systems Committee (NTSC) standard of a 525-line picture. (HDTV systems have about double that amount of lines to produce a wider-screen, movie-quality picture.)

In addition, the FCC said any approved HDTV technology could not use any more of the existing television frequency spectrum than was already being used (a 6 MHz-wide band per channel). The Japanese prototype, entitled MUSE, didn't meet either stipulation.

Individual research and development efforts in the United States began at about the same time as the FCC ruling. Then, with strong urging from the FCC Advisory Committee on Advanced Television Service (ACATS), the Digital HDTV Grand Alliance (GA) was formed in May 1993. The seven-member GA includes American Telephone & Telegraph (AT&T), the Massachusetts Institute of Technology (MIT), General Instrument Corporation, Philips Consumer Electronics, Thomson Consumer Electronics, Zenith Electronics Corporation and the David Sarnoff Research Center.

After two years of intensive collaboration between the GA's private-sector members, a digital HDTV system prototype has been developed that meets FCC requirements. Some observers believe the digital format of the GA's HDTV system can also be used to enhance the quality of the standard NTSC picture as well.

Meanwhile, Japan's analog-based MUSE system, developed at an estimated $1 billion cost, is in serious trouble. Both Europe and the United States have taken the high tech road towards development of digital HDTV, essentially leaving Japan in the research dust. While it may be a bitter pill for the Japanese high technology community to swallow, most industry observers agree they will eventually halt further analog HDTV development (some say the sooner, the better). In fact, some Japanese firms have already formed strategic alliances with American firms that are developing digital technology.

After final laboratory tests at the Advanced Television Test Center in Alexandria, Virginia, and broadcast and cable field testing in Charlotte, North Carolina, the GA HDTV system is expected to receive FCC approval by the end of 1995. GA participants are predicting consumers will be able to buy their first high definition TVs in 1997. And, as a result of a unique private-sector effort (heartily encouraged and supported by the FCC), America's flagging television industry may finally be on the rebound.

Interactive Television: A Great Idea Whose Time is Coming...Eventually

If the amount of money being poured into research and development is any indication, interactive television has a definite future in the United States . Major corporations have committed billions of dollars to upgrade existing communication delivery systems and to develop new technology that will act as the core of a working interactive system.

Interactive television is, by its very nature, a technology of convergence among television, telephone and computers. Fortunately, American homes are saturated with some of the basic technological building blocks of interactive TV: telephones, 93.7 percent; televisions, 98.3 percent; cable television, 63.4 percent). The interactive challenge is to come up with a universal system combining all the elements in an easy-to-use, efficient, economical system that will serve millions of homes, all at the same time.

The key component or service of interactive television is video on demand (VOD). While it sounds simple enough, the ability to provide this service to thousands of households at the same time is enormously complex. Not only must the service provider be able to offer hundreds of video titles at any given time, but the viewer also expects to have the ability to stop, start, rewind and review the video at any time. Not only does the interactive system have to allow such individual control, but it must be able to compete with $3 video rentals, as well.

Other interactive services touted by industry observers involved in this multi-billion dollar gamble include: on-demand news, financial and sports services; home shopping (clothing, cars, major appliances, jewelry, groceries, etc.); medical check-up services; music-on-demand; and home banking and bill paying services. Consumers may also be able to use their interactive televisions to monitor and control their home energy management systems, answer the telephone and record messages, as well as tap into on-line services and download vast amounts of information (data, voice and video) for personal, professional or business purposes — all at blinding speeds.

Depending on who is talking, the revenues to be generated, from everyday VOD to a host of specialized interactive shopping malls, range from merely fantastic to astronomical. One forecast of a $1 trillion market within a decade is not all that hard to imagine, given that there are currently more than 95 million television households in the United States (60 million of which are already wired for cable).

With $1 trillion market projections dancing in their heads, American communication and information leaders are hard put to resist the lure that interactive television presents. The race to develop a working model of an interactive system has brought two formidable adversaries eye-to-eye over the future interactive television will take: America's cable television providers and the nation's local telephone providers or regional Bell operating companies (RBOCs).

Each has particular technologies, existing infrastructure and distinctive strengths that lend themselves to developing a functional interactive television system. And, to top it off, they're both trying to break into each other's core businesses.

The cable industry's abilities to participate in an interactive system are backed up by a hard-driving desire to develop such a system as soon as possible. Major cable companies — Tele-Communications, Inc. (TCI), Time-Warner, Cox Communications and Jones Intercable — are spending billions of dollars to develop various aspects of an interactive television system.

The most ambitious and scrutinized test to date is Time-Warner's Full Service Network (FSN) test in northern Florida. The $5 billion, five-year test brings together American Telephone & Telegraph (AT&T) switching technology to route data; Silicon Graphics' operating software and storage hardware; and Scientific-Atlanta's converter (set-top box) technology to bring the interactive network into selected homes in Orlando, Florida.

Originally scheduled to begin in April 1994 with 4,000 subscribers, the FSN was finally introduced in December 1994 with barely a half-a-dozen homes on-line. Yet, despite this humbling experience in interactive development, the FSN test has made some important strides in basic interactive technology.

Although limited in scope, FSN does offer VOD, with fully functioning viewer control of the video, including pause, stop, and rewind/review functions. Viewers can even halt their movie videos to take a stroll through a computer-generated shopping mall or visit a video-game area to play an interactive game of cards with their neighbors.

The real challenge will be not only to expand the roster of interactive services for the first half-dozen subscribers, but the basic service itself to the thousands of homes originally envisioned in the test as well. Only then can the true economics of an interactive system really be worked out.

"Siliwood": That's Entertainment in the 21st Century

California's famed boom and bust cycles have touched all its key industries at one time or another. That includes the Hollywood studios, its vast aeronautics and defense facilities, as well as the famed computer industry in the Silicon Valley. However, the latter half of the 1990's will see a startling convergence of two of those industries that will fundamentally change the way Americans, and the rest of the world, are entertained.

The merging of the Silicon Valley and Hollywood, creating what some call "Siliwood," is really no laughing matter. Except, that is, for those who will be chuckling all the way to the bank when this dynamic partnership really starts cashing in on the multimedia products it has just begun to produce.

The feverish Gold Rush atmosphere that has overtaken Hollywood and computer executives alike is being fanned by the race to develop interactive systems for television and movies (and anything else they can think of as they go along). As a stopgap, until mass market interactive systems are perfected technologically, Siliwood residents are pouring their considerable talents, a good deal of their time and huge amounts of money into increasingly sophisticated computer games and interactive CD-ROM94 programs...the Alamogordo testing grounds for what many consider to be America's explosive interactive future.

While Silicon Valley and Hollywood are bubbling with related research and startling uses of the latest computer-driven special effects (Steven Spielberg's *Jurassic Park*, Arnold Schwarzenegger's *True Lies* and Sylvester Stallone's *Judge Dredd*, to name a few), a real hotbed of interactive creativity can be found in Siliwood's unofficial capital, Multimedia Gulch.

Centered around San Francisco's SOMA (south of Market district) area, the Gulch is home to dozens of startup multimedia companies formed by interactive innovators with wide-ranging backgrounds. Many of these companies are made up of Hollywood performers, directors, writers and producers and hard charging computer cowboys from the Silicon Valley, many of whom are risking all they have to be on the cutting edge of America's interactive future.

But they are not totally alone. These digital pioneers are attracting a lot of interest, and lots of money, from major media and telecommunication companies, many of whom have their own interactive research underway. Such corporate heavyweights as Paramount

Pictures, Viacom, AT&T, Home Box Office, Inc. (HBO), King World Productions and Time-Warner, Inc. have formed partnerships in the Gulch with a number of these interactive trailblazers.

No one in Multimedia Gulch is quite sure how much Hollywood magic and raw computer power it's going to take to make interactive TV and movies an everyday reality. But, that doesn't stop them. They're forging ahead to produce interactive products that achieve new levels of reality and fantasy. The increasingly sophisticated video games and CD-ROMs contain software that combines digital footage with real actors and sets, animation, special effects and simulation all tied together with intricate plots and backed up by full-blown musical scores. It's this "content," as it is known in the Gulch, that will drive entertainment's interactive future on television and eventually the big screen.

While the current comings and goings of Multimedia Gulch are of concern primarily to those in the industry, one of Siliwood's most high profile multimedia developments to date is the formation of a new studio, DreamWorks SKG, by three of Hollywood's biggest movers and shakers: Steven Spielberg (*Jaws*, *E.T.* and *Jurassic Park*), Jeffrey Katzenberg (who revived Walt Disney's animated feature fortunes) and David Geffen (famed recording executive who struck it very rich with such stars as the Eagles, Guns N' Roses and the long running Broadway show *Cats*, to name a few).

Each of the three principals put up $33.3 million as seed money for the SKG venture. But it's their names and reputations that are bringing in the really big bucks. That includes a $1 billion line of credit from Chemical Bank and $500 million from Microsoft co-founder, Paul Allen, to name just two.

What's the attraction? As *Time* magazine's show business correspondent Richard Corliss pointed out, "DreamWorks will be the prototype plugged-in multimedia company of the new millennium." SKG's primary objective is to make the best and most advanced movies, TV shows, music, toys and computer software available. And a good part of its success will come through strategic alliances with dynamic innovators and thinkers in key industries.

HBO, MCA-Matsushita, IBM and Microsoft are only of few of the corporate powerhouses that are negotiating dream deals with SKG. DreamWorks' entry into broadcast television (interactive and otherwise) was put in place with the announcement that SKG and Capital Cities/ABC Inc. had formed an alliance to start a new television studio. The joint venture will produce morning, daytime, prime-time and other programming, including movies and mini-series.

Meanwhile, one of California's biggest utilities, Pacific Bell, is in the process of developing a revolutionary statewide electronic network that will determine how Siliwood professionals will work together, whether they're multimedia wizards in the Gulch, studio executives in Hollywood or computer jocks in the Silicon Valley.

Technically speaking, Pacific Bell's Media Park, which is currently undergoing tests and is slated to be commercially available in winter 1995-96, is a very sophisticated broadband communications network that will make Siliwood a reality...a seamless blending of Hollywood and the Silicon Valley into one unit, one industry. In essence, it will become the world's first virtual production studio for the state's vast and powerful entertainment, multimedia and marketing industries.

Industry professionals will be able to use Media Park to scout locations, search for actors and production personnel from desktop computers. They'll be able to create and deliver animation, video and audio on-line. Sound and special effects, video footage and even backdrops will be located, studied and licensed via personal computers. Directors, producers and other media personnel will be able to edit raw footage from multiple locations and then store their efforts electronically in the film or video format of their choice.

More than 30 companies have been chosen to participate in the Media Park technology tests. They include Paramount Studios, the American Film Institute and the famed BBDO advertising agency, among others.

The value of the system lies not only in what it will do for major media concerns like Paramount or Universal, but also in the access to resources it affords even the smallest media organizations, such as the struggling interactive companies in the Multimedia Gulch. Media Park will give them ready access to such things as the Kodak Picture Exchange (KPX) and its database of more than 100,000 still images, as well as the Eastman Exchange (E2), which features more than 5,000 photos of production locations throughout the world.

In addition, Media Park users will be able to access vast video clip and stock footage databases featuring vintage newsreels, animated cartoons, outdoor scenes and a huge selection of backdrops. Media professionals will also be able to track down and retrieve appropriate themes from a large production music library (out of more than 1,000 possibilities) and conduct talent searches from an interactive database that features video clip auditions.

While Siliwood may never be a specific destination on any airline's flight plan, it would seem from all the activity that's taking place in California that it will be the destination of choice for anyone who wants to be a part of America's interactive future. While California's latest (and probably most lucrative) Gold Rush is just getting started, it's not hard to see that the United States and the world of popular entertainment will never be the same.

Broadcast Deregulation Gains Momentum

The debate about telecommunications regulation, in particular the Federal Communications Commission's (FCC) role in this area, touches on issues that could raise or ruin America's chances to maintain its dominance in this vital global market.

The fact that the FCC, particularly in its oversight of broadcast operations, has already mandated considerable deregulation is well-established history. The move began with minor rule changes in the 1970's. Then, in 1981, after a four-year study, the FCC eliminated four well-established restrictions on radio broadcasters: the long, laborious studies to determine local community needs to back up programming decisions were dropped; program log-keeping rules were ended; and guidelines for minimal levels of non-entertainment programs and maximum levels of advertising on the air were also eliminated.

Similar deregulation moves were made in educational radio and television. Commercial television changes soon followed. In fact, after an extensive study of network television in 1979 to 1980, the FCC staff recommended that most existing network rules be done away with completely. In reaching their decision, the staff argued that most of the regulations put in place to encourage program diversity had failed. The rules, the staff reported, had in fact often suppressed competition by protecting the networks from new competitors such as cable.

When the FCC tried to implement the staff recommendations, the commission ran into a virtual wall of special interests that put a halt to wholesale broadcast TV deregulation. Program syndicators, who got their start with the prime-time access rule (PTAR), wanted to keep it on the books. This, despite the fact that PTAR had failed in its original intention to restrict network domination of evening television. The networks were also chafing under strict financial and syndication rules. These "fin-syn" rules prevented the networks from owning major parts of the programs they aired or syndicating them after they completed their first run on the networks. Efforts to eliminate PTAR and the fin-syn rules were finally thwarted when President Ronald Reagan ordered his policy body (the National Telecommunications and Information Administration — NTIA) to argue for the rules. Under NTIA pressure, the FCC eventually halted the deregulation move on these two critical issues.

The move to lessen the power of the FCC, along with a good deal of the federal government, gained critical momentum with the November 1994 elections. Barring any last minute bureaucratic roadblocks, the FCC is scheduled to drop the infamous fin-syn rules in late 1995.

What impact will this have? No one is quite sure. As Richard Zoglin, a *Time* magazine correspondent reported, "The line between distributors (the networks) and suppliers (outside producers) is being blurred. The networks, given the chance to produce and own the shows, are acting more like studios, while the studios, afraid of being squeezed out, are trying to become networks."

A case in point is Capital Cities/ABC which has already announced a joint venture to create a TV studio with Hollywood's newest movie studio in nearly half a century (DreamWorks SKG). In addition, two new "networks" have also entered the broadcast competition. After ABC, CBS, NBC and Fox, now comes Warner Brothers (WB) network and the United Paramount Network (UPN).

Other changes are in the offing. Major telecommunications deregulation is being discussed in the halls of Congress. This includes letting cable companies compete with regional telephone companies and vice versa, a major "level playing field issue" between the two major interactive TV contenders. There's also talk of revisiting cable rate regulation.

The political pendulum is obviously swinging towards greater deregulation of the telephone, broadcast, cable and DBS industries. Barring the uncovering of a monopolistic plot to control the broadcast spectrum, deregulation is definitely the wave of the foreseeable future. However, the bottom-line question remains: how will it affect (if at all) what viewers see in their living rooms? Only time and technology will tell.

Standards and Convergence: May the Best Technology (& Software) Win

Setting standards in telecommunications is no easy matter. Especially in today's deregulated atmosphere. And that poses a host of problems in the Information Age, when all the technology is purportedly coming together. Whose technological framework, whose software configuration, whose operating system will be used to tie all the facets of a full-service interactive network together?

The answer, for better or worse, probably will not come from the FCC or any other related regulatory agency in the federal government.

When broadcast radio first took hold in the 1920's, the government's hands-off attitude led to a chaotic situation of unregulated start-up radio stations bouncing all over the broadcast spectrum. Listeners spent more time trying to battle interference from competing stations than they did listening to their favorite radio shows. Things got so bad that even President Calvin Coolidge, a singular icon for free market enterprise, demanded Congress take action. The result was the first comprehensive communications act in the nation's history.

Generally, the United States broadcast radio industry has followed guidelines established by the International Telecommunications Union (ITU), which evolved from a related organization that was established in 1865 to coordinate international use of the telegraph. Today, the ITU and its signatory members, as an affiliate of the United Nations, develop and adopt rules governing international wire and wireless communications.

Not only does it establish the procedures for the international exchange of communications, but it also standardizes the terminology in the various telecommunication fields. And, with the increased dependence on satellite communications worldwide, the ITU has even been involved with allocating satellite positions in geostationary orbit for the various nations involved.

While America's radio industry has "toed" the ITU line fairly closely, television has not. In fact, today there are 14 different monochrome (black and white) technical standards worldwide, as well as three color standards (the United States, France and Germany). Unfortunately, this has established a precedent that has repeated itself with other telecommunication industries in the United States.

When television burst upon the scene in the 1950's, it soon became apparent that the next big development in the industry would be color broadcasting. The FCC took a strong part in the debate, eventually setting the ground rules for color research and development. Bottom line, the FCC demanded that any color system developed and approved must be compatible with existing black and white televisions and be able to operate in the allotted 6-MHz wide channel band. A committee of the nation's major television manufacturers developed and had approved what became known as the National Television System Committee (NTSC) color standard, which, of course, was not compatible to either the French or German color systems.

This "cowboy" approach to setting standards has affected other telecommunication industries. A split over digital cellular standards in the United States, for example, has boosted the acceptance of a unified European standard worldwide. The shakeout over high definition television (HDTV) standards is still in doubt.

The Japanese were first off the mark when they began developing their analog HDTV system in the mid-1980’s. Both the Europeans and the Americans responded to the challenge (and the newly perceived threat to their television manufacturing industries) and began to work on their own HDTV systems.

The United States system is fundamentally different from the Japanese system because it is based on digital technology, an offshoot of technological developments in the satellite delivery of encrypted programming to cable television systems. Digital technology is fast becoming the basis for interactive television.

With the strong support of the FCC, a Grand Alliance of HDTV system proponents was formed to develop an American HDTV system that is able to operate in the 6-MHz wide channel band.

This unique cooperative effort between a government regulatory agency which sets broad parameters and the private sector which actually develops the standard would seem to be the perfect formula for success. The FCC cannot act until there is something presented to them, and the Grand Alliance HDTV system is still being tested. Also the broadcast industry is suddenly asking that significantly different standards now be tested as well. In effect, the industries don’t seem to want standards yet.

However, the argument has been made that in the future, as the price of computing power falls, compatibility will be easier to achieve with software. As a case in point, observers look at Hughes Electronics’ development of its digital satellite television system (DSS). Hughes, eager to get its system on-line, went ahead and developed its own compression system while what became the standard, MPEG 2, was still being developed. The incompatibility issue was quickly resolved with two kinds of software put into Hughes decoders, which allowed the two compression technologies to coexist in one system.

As the battle for an interactive information superhighway continues, the urgency for compatibility, through established standards or protocols, will increase. Yet, unless there is an overwhelming demand from the private sector companies involved (and certain antitrust or restraint of trade issues are waived), the FCC does not appear inclined to step in to either suggest wide-ranging parameters or dictate specific standards. The true test of any universal interactive system may indeed be in the technology, and more importantly, the software that makes it user-friendly no matter what equipment consumers possess.

u contributed by Michael C. Lafferty

Luskin, Bernard J. (1939 –   )

American businessman, educator and author, currently the Chief Executive Officer (CEO) of Jones Digital Century, Inc. (JDC), a company of telecommunications-giant Jones International, Ltd., headquartered in Englewood, Colorado. Jones Digital Century, Inc. is a leader in the interactive computer, telecommunications and publishing industries. Luskin is primarily known for pioneering computer assisted instruction, telecourse education, new media psychology, and interactive CD-ROM technology.

Luskin received degrees from the University of California at Los Angeles (Doctorate), California State University at Long Beach (MBA), California State University at Los Angeles (BBA) and Long Beach City College (AA). He completed additional graduate studies at the University of Southern California (USC) and California State University at Fullerton. Luskin is a licensed psychotherapist.

Intrigued with the power of television, technology and education, Luskin has spent a lifetime using and improving the medium for the intellectual betterment of viewers and learners. As a pioneer in new-media psychology, he has contributed significantly to the foundation and format of distance education. He has held numerous titles and positions at a variety of educational institutions, including USC, UCLA, Claremont Graduate School and Pepperdine University (California). Equally active in California's community colleges, Dr. Luskin was Vice Chancellor at Coast Community College District, founding President and CEO of Coastline Community College, and President and CEO of Orange Coast College. Highly respected in community college circles, Luskin was formerly Chairman and Executive Vice President of the American Association of Community Colleges.

Publishing has also been a strong suit of Luskin's. Over 200 articles and seven books carry the Luskin by-line, while several journals have carried his name as editor or publisher.   He has also served as executive producer for Emmy award winning telecourses.

Dr. Luskin has used his many talents in both the public and private sectors. As a founder and Vice President of Education at KOCE-TV, he pioneered telecourse education and produced many courses aired on television. Luskin was also the founding President and CEO of Philips Interactive Media of America, and President of Philips Media Education and Reference Publishing Group. While at Philips, Luskin aided in the development of CD-ROM technology, including interactive CD-ROM and CD-I. This development alone would be noteworthy in an educator and scientist's lifetime; however, Luskin has contributed in many other areas. He also effected a deal with Paramount Home Video which put the first digitally compressed MPEG (Motion Picture Expert Group - an industry standard) movies on a CD.

Luskin joined Jones International in February 1994, when founder Glenn Jones asked him to develop the interactive team as the new interactive company CEO. Luskin was an ideal choice to lead the new unit. Under Luskin, Jones Digital Century, Inc. will continue to produce numerous educational and reference programs both on-line and in CD format.

Jones Digital Century, Inc. will be a significant player in the emerging new-media industry.

u contributed by Michele Messenger

Broadcast Television: History & Development

The 20th century has had more than its fair share of momentous developments. But, when it comes to affecting the everyday life and behavior of John Q. Public, nothing surpasses the impact television has had in its first 50 years of commercial broadcasting. Along the way, from its start as a scientific curiosity in the early 1900's to the multi-billion dollar industry it has become as it nears the end of this century, broadcast television has profoundly and irrevocably altered the way people view and interact with the world around them .

In the Beginning — The First Steps in Broadcast TV Technology

The basic concepts of wireless picture transmission have been around since the late 1880's. Unfortunately, neither the people nor the appropriate technology to take the next step were in place until the late 1920's. It took a self-taught American inventor, Philo T. Farnsworth , and an immigrant Russian engineer, Vladimir Zworykin, to put America on the threshold of electronic television broadcasting.

Farnsworth's image dissector tube performed the critical task of breaking an image into minute portions, each with its own light value, so that it could be reassembled electronically to reproduce the original image. Zworykin, meanwhile, as the leader of a famed research group at RCA laboratories, developed a similar electronic system, and in fact, ended up in a seven-party patent suit that included Farnsworth.

Farnsworth's efforts got the judicial nod of approval in 1934 and eventually garnered RCA's acknowledgment of them in 1939 when RCA paid him $1 million for the right to use his patented discoveries. But it was Zworykin , along with his iconoscope camera tube and his team of RCA researchers, who finally brought television quite literally into the public domain.

Throughout the 1930's, Zworykin and his team in Camden, New Jersey, struggled to produce a better quality picture. They even placed sets in homes on an experimental basis. Finally, in 1939, they felt ready to go public. Appropriately, modern broadcast television made its debut at the 1939 New York World's Fair under the aegis of its World of Tomorrow theme.

The first commercial broadcast was beamed over American airwaves July 1, 1941, by WNBT in New York (now WNBC-TV). WNBT had been operating since 1928 as an RCA experimental station and began abbreviated regular service in 1939. By the time it went commercial, there were approximately 4,000 television sets in the New York area. However, the advent of World War II effectively put a halt to the expansion and growth of broadcast television for the masses.

The End of WWII Signals the Beginning of Modern TV

With the end of World War II, broadcast television finally got the impetus it needed to expand. The fodder for television growth was found in the millions of GIs returning from overseas looking for their piece of the American dream. Television's first mass audience was assembled to watch the World Series in 1947. The series spurred more demand for

TV sets, while the growth in TV set sales prompted expanded programming by the television stations.

Finally, the debut of broadcast television as a mass market entertainment venue took place on June 8, 1948, with the premiere of Milton Berle's *Texaco Star Theater*. This hit weekly comedy-variety show ignited programming fires throughout the industry, and modern broadcast television, for better or worse, was on its way.

Yet, in one important way, 1948 would also be the year the industry was forced to catch its breath. It was the same year the number of television stations and the number of cities served nearly tripled (from 17 to 48 and 8 to 23, respectively). TV set sales shot up more than 500 percent over 1947 levels. This explosive growth worried industry insiders who were scrambling for channel assignments and also concerned the Federal Communications Commission (FCC), which, as the regulatory agency for the nation's communication industries, was responsible for making those assignments.

The problem was that until 1948 the FCC had made only 12 VHF stations available for the whole country. This was especially telling when compared with the 107 AM and 100 FM channels that had been allotted for radio. The FCC took action in September 1948 when it announced a freeze on television license applications. After nearly four years of studies and hearings, the FCC announced its Sixth Report and Order in 1952. The report established an additional 70 UHF channels (channels 14-83) and awarded more than 2,000 channel assignment slots for use of one or more channels in each of 1,291 communities around the country (as compared to just 345 cities before the freeze). While the Sixth Order was hardly perfect and many inequities still existed, the floodgates on TV's growth had been opened, and the established networks stepped in to capitalize on this new industry.

Television Takes Its Cue from Radio — Lock, Stock & Advertiser
The best thing that ever happened to broadcast television was commercial radio. In fact, the three major TV networks — American Broadcasting Companies (ABC), CBS Inc., and the National Broadcasting Company (NBC) — all started as radio networks. And, it was no accident that a large part of the television's technological development was underwritten by the radio networks themselves, particularly NBC through its association with parent RCA.

Radio broadcast networks and their affiliates also served as the model for a similar system in broadcast television. The arrangement involves a contract between a privately owned local station and one of the networks. The station agrees to run network programs and commercials for an agreed-upon fee. The local affiliate also has the opportunity to sell and run local advertising in specific spots during network programs. These commercial spots, because they're sandwiched in during a high-profile, national program, usually earn top dollar ad rates for the local station.

The arrangement gives the network the outlet it needs for its national programming and advertisers, and the affiliate gets programming that draws big audiences. And, because the network is providing as much as 50 to 60 percent of the programming, the affiliates' expenses are much lower than that of a non-affiliated station.

In addition, the radio program formats — comedy-variety shows, dramas, mysteries, etc.

— and their advertisers made a nearly seamless transition from radio to television. Despite the fact that television production techniques were a definite work-in-progress in the late 1940’s and the 1950’s, the numbers were there and the advertisers were scrambling to foot much of the bill to bring broadcast television into its own.

The growth in television set sales during this time was staggering. In 1949, there were an estimated 1 million sets being used. Just two years later, in 1951, more than 10 million were in use. By the end of commercial television’s first decade, eight years later, the United States boasted 50 million television sets in place.

This unprecedented demand for television created an almost wild west atmosphere in the burgeoning industry. This wide-open, anything’s possible mindset brought about an extraordinary convergence of talent and accumulated power both behind and in front of the TV camera. The three major networks that would dominate broadcast television for the next quarter century were primed and ready.

Broadcasting in the 1950’s — TV’s Golden Age

The 1950’s were broadcast television’s wonder years . Everything was new. Many, if not most, things were being tried for the first time and, for a good part of the decade, it was all being done on the edge — live broadcasting.

But these were also the years that the industry created and formed the basic programming techniques and formats on which it would build its future success. It was during this time that network executives were experimenting with what would appeal to a majority of the rapidly expanding TV audience. While many critics have panned the formula approach to programming that the networks created during this time, the fact remains that the 1950’s scramble for audience appeal spurred an unprecedented level of creativity that’s still admired and studied today.

The economics of the industry and the fact the networks had to produce shows that could be telecast in four different time zones finally brought an end to most live broadcasts. As the technological barriers to producing programs on film fell to the wayside, along with the introduction of videotape in 1956, the networks gained more flexibility in scheduling broadcasts and reruns of programs they were able to put in the can weeks and months before.

Finally, the 1950’s also gave the viewing public a good glimpse of the lofty heights that broadcast television could achieve, as well as the depths to which it could sink. The famous broadcast of Edward R. Murrow’s *See It Now* on March 9, 1954, showed the positive power of the medium when Murrow took on America’s leading demagogue, Senator Joseph R. McCarthy (R-Wisconsin). His wide-ranging witch hunts for communists had paralyzed more than one government agency and a number of industries, including that of entertainment.

When McCarthy was at the peak of his highly publicized campaign to rid the country of communists in the early 1950’s, the snowballing television industry showed little backbone against the senator’s rampages. The blacklisting of entertainers and other production professionals became an open secret in the industry and didn’t really disappear until the early 1960’s.

But Murrow’s *See It Now* telecast, along with gavel-to-gavel broadcast of McCarthy’s senate subcommittee hearings later that year, helped put an end to the senator's career when his colleagues in the Senate voted to censure him.

The 1950's also illustrated broadcast television's feet of clay. The infamous quiz show scandals of the late 1950's showed the inherent weakness of single-sponsor programming and ignited fiery debates about broadcasting's role and responsibilities.

Quiz shows were all the rage in the mid-1950's with such hit shows as *The $64,000 Question* (CBS) and *Twenty-One* (NBC). Producers and sponsors alike tried to glean every rating point they could with struggling (but well-coached) winners overcoming repeated challenges week after week. When investigations in 1958 and 1959 proved widespread fraud and rigging, the shows quickly plummeted in appeal. Ethical (and allegedly cosmetic) reforms followed, as well as the networks' realization that they had to exert more control over programs and limit sponsor involvement.

Broadcasting in the 1960's & 1970's — The Vast Wasteland Flourishes
The cynicism born out of the quiz show scandals in the late 1950's carried well over into the 1960's. In fact, Newton Minow, the FCC's newly appointed commissioner in 1961, summarized the situation quite succinctly, at least for TV critics, in a famous speech before the National Association of Broadcasters.

But when television is bad, nothing is worse, declared Minow. I invite you to sit down in front of your television set when your station goes on the air and stay there...and keep your eyes glued to that set until the station signs you off. I can assure you that you will observe a vast wasteland. That wasteland, according to Minow, was made up of an endless line of shows that contained unacceptable levels of blood and thunder, mayhem, violence, sadism, murder...private eyes, gangsters, more violence, and cartoons. And endlessly, commercials — many screaming, cajoling, and offending.

Despite Minow's dire assessment of the industry, broadcast television was just hitting its stride in the 1960's and 1970's...and in color, too. The battle for color technology had been won in 1953 by RCA, which had developed an electronic color system that was compatible with existing black and white televisions. But, due to the cost of color receivers and lack of advertiser interest, it really didn't catch hold until the mid-1960's when NBC (taking the lead on behalf of RCA color television sales) offered its complete prime time lineup in living color. The other two networks quickly, although grudgingly and at great expense, followed suit.

Two other important developments for broadcast television's future occurred in the 1960's. In 1962, Congress passed legislation (termed the all channel law) that allowed the FCC to mandate that all televisions manufactured, sold and shipped via interstate commerce after April 1964 have the ability to adequately receive all 70 UHF channels, as well as the 12 VHF channels. As a result, faltering UHF stations were finally put on an even keel, at least regarding reception, with the more popular VHF stations. It also gave communities where all VHF assignments had been used up the opportunity to expand selection with new, and now more easily accessible, UHF stations.

Then in 1967, Congress, with President Lyndon Johnson's strong urging, enacted the recommendations of the 15-member Carnegie Commission on Educational Television. The two-year study, titled *Public Television: A Program for Action*, documented the need to establish a public television system that would address public service and cultural enrichment in the widest sense. This system, the report suggested, would have a national scope yet be aimed at and directed by local concerns.

The legislation passed by Congress created a triumvirate to oversee public broadcasting. The Corporation for Public Broadcasting was established as the public broadcasting policy maker. The Public Broadcasting Service (PBS) was a collection of stations brought together to (sometimes) produce and distribute programs nationwide. The legislation also set up a system of funding that included the federal government (whose funding averages about 14 percent of the PBS budget), private foundations and corporations, as well as viewer donations and/or sponsoring memberships.

Yet, broadcast television in the 1960's and 1970's had its biggest impact from the public's point of view in the stark, unflinching images it brought into American homes in times of national achievement, crisis and confusion. The power of the medium's immediacy in this regard was first suggested in the coverage of the sit-ins and the freedom rides to desegregate the South in the late 1950's and the 1960's. But it was the assassination of President John F. Kennedy in November 1963 that proved to be the watershed event that helped to create a national, if not worldwide, television community.

For four days that cold and bleak November, the nation and the world watched events unfold in an almost surreal tableau. First the news of the assassination itself. The frantic search for an assailant. The suspect's subsequent murder on national television. The mournful, eerie funeral procession with its indelible image of the slain president's young son saluting the casket as it passed by.

The trauma of this nationally televised event seemed to linger in the public consciousness and was devastatingly revived with the television images that chronicled the assassinations of Martin Luther King and Senator Robert F. Kennedy just five years later in 1968. The Democratic Convention riots later that summer seemed to generate an almost collective twitch in the viewing public whenever a news bulletin headline interrupted regular network programming (l-r: Chet Huntley, David Brinkley).

Of course, underlying it all, was the nightly coverage of the Vietnam War, America's first and most traumatic televised war. The battleground was no longer an abstract paragraph in print, but a litany of full-color images and bloody action viewed over America's dinner tables .

Amid all the carnage and confusion, broadcast television was also a bearer of good tidings as well. This was particularly evident in the networks' coverage of the race to the moon in the 1960's. From the first brief space shots down range from Cape Kennedy in Florida, to man's first steps on the moon in 1969, broadcast television kept the public intimately involved with this singular human effort .

Broadcast television continued its role as an eyewitness to history when it put viewers in the halls of Congress during one of this century's most intriguing political dramas — the 1973 Senate Watergate hearings. Day after day, week after week, the TV camera focused its attention on a cast of political movers and shakers gone awry. As the vote of impeachment drew near, the viewing public held its breath, awaiting the next dramatic development or turnaround. The final, irrevocable shoe dropped on August 8, 1974, when a beleaguered President Richard M. Nixon took to the airwaves to resign the office he had strived his whole life to achieve.

As far as the broadcasting television industry was concerned, the 1960's and the 1970's, while enormously profitable, were also the time when the networks' most serious competitor would establish itself. Yet broadcast TV's campaign to limit cable television in the 1960's was fairly successful. The increasing pressure from the networks resulted in stricter FCC regulations on cable companies on a piecemeal basis.

Finally, in 1972, the FCC issued its definitive regulations on expanding cable operations. The newly issued rules put severe restrictions on the kind and number of signals that could be brought into larger cities. The cable industry was compelled to provide, on request, all kinds of access channels for the general public, governments and educational organizations.

Yet, by the end of the decade, after some favorable court rulings, a change in both the administration and FCC leadership these rules were eliminated. Slowly, Washington's involvement in regulating the cable industry, much to the alarm of the broadcast networks, began to dissolve. Broadcast television would never be the same.

Broadcasting in the 1980's, 1990's and Beyond — A New Reality

The broadcast television networks' iron grip on America's viewing audience had been slowly loosening since the late 1960's and 1970's. As cable television grew stronger, the broadcast networks grew more nervous. Finally, the networks' lock on their huge market share was officially ended with the Cable Communications Policy Act of 1984.

The legislation ended a variety of restrictive regulations, particularly on pricing, gave way to more strict local standards regarding programming and service and instituted new regulations aimed at cutting down cable competition, especially from phone companies. While the Act may have put the official seal on cable's ascendancy in 1984, the broadcast networks had already seen it coming and were scrambling to adjust.

A number of forces came together in the mid-1980's that basically changed the face of network broadcast television. This included a drop in the network's share of the prime time audience. In 1978, the networks held sway in 90 percent of those homes. Just ten years later, that had dropped precipitously to 70 percent and it was still going down. In addition, the network's first generation of leaders had now become the old guard, and their days at the helm were numbered. Added to that fact was the economic tenor of the times. During the 1980's, takeovers and leveraged buyouts were rampant, and network television was a prime target.

The first big buyout shock came in January 1985 when Capital Cities Communications took over ABC for $3.5 billion. Considering what was going on at CBS and NBC, the Capital Cities-ABC merger was the most successful. At least ABC was bought out by a company in the same industry.

Meanwhile, over at CBS, various presidents appointed by William Paley had been playing musical chairs for a number of years. Paley's penchant for appointing an heir-apparent and then sacking him in favor of still another finally forced the board of directors to take action. In 1983, the board and its then threatened President, Thomas

Wyman, forced Paley out as an active participant in the network's daily affairs.

Takeover bids and threats at CBS mounted. At the beginning of 1985, Senator Jesse Helms (R-North Carolina), a far right icon, launched a public drive, but not a serious threat, to acquire CBS and become Dan Rather's boss. But a junk bond bid by cable entrepreneur Ted Turner in April 1985 sent off alarm bells in CBS corporate offices. The network was desperate to find an alternative and started talking to others including General Electric, Gannett, and the Loews Corporation.

In the summer of 1985, CBS finally decided to cast its lot with the Loews Corporation and its president, Laurence Tisch. The background machinations of the takeover eventually cost Wyman his job, and Tisch took over daily control of the network in late 1985. To service the debt incurred to thwart the Turner bid, a major shakeup at the network ensued. Thousands were laid off, an aggressive diversification plan launched in the 1960's and 1970's was abandoned, and CBS Records was sold to Sony Corporation for a much needed $2 billion.

The takeover of RCA/NBC by GE in 1985 was no less traumatic. While RCA had considered mergers with MCA and the Disney Company, the $6.3 billion bid from GE was the only solid offer that materialized. With it, RCA ceased to exist and a whole new corporate culture, one geared toward stockholders instead of the public, was put in place. Shortly after the takeover, the NBC radio network that had made the NBC television network possible was sold.

Despite all the financial flip-flops that the television broadcast industry was undergoing in the 1980's, there was still room for another player. The debut of Fox Broadcasting Company in November 1986 and its growing success were proof that broadcast television was not an endangered species.

The story of the Fox network is really the story of Rupert Murdoch, one of the world's media giants. His purchase of 20th Century Fox and Metromedia's six independent major-market stations in 1985 served as the core for the Fox network. Instead of taking the big three networks head-on with a full line of prime time offerings, Fox took a programming approach that seemed more like guerrilla warfare.

Under the creative leadership of former Hollywood studio executive Barry Diller, Fox took risks targeting its shows (*The Simpsons*, *Married...With Children*) towards younger adults on specific nights. Fox also got a jump on the other networks when it decided to premier a number of its new shows in August, while the other networks were serving up endless reruns. The combined strategies have worked, and the network now offers a full lineup of shows, seven days a week. In fact, its creative programming has finally started to achieve critical mass as well. In 1995, its cult hit, *The X-Files* (a unique hybrid of *The FBI Story* and *The Twilight Zone*) , crossed over to mainstream popularity and critical acclaim when it won a Golden Globe award as broadcast television's best dramatic series.

The future of broadcast television, while it may never approach the halcyon days of profit and glory in the 1960's, is not all that bleak either. Undoubtedly, there will be further realignments, takeovers and new technology. High definition television (HDTV), for example, is just over the horizon.

Programming pressures from cable networks, the Fox network, and two newcomers (Warner Brothers [WB] and United Paramount [UPN] networks) will force the big three networks' hands creatively and strategically. In fact, ABC has already led the way in diversifying its options with successful stakes in the cable industry, including stakes in ESPN (80 percent), the Arts & Entertainment (A&E) network (38 percent) and the Lifetime network (33 percent).

One fact is assured however. Viewers won't have to worry about being bored with the status quo.

u contributed by Michael C. Lafferty

Broadcast Television: How It Works

Like most modern technologies, television did not come about as an individual phenomenon. It is a convergence of technologies, scientific theories and basic forces of nature. Television's technological and theoretical stew includes a variety of ingredients including such basics as how humans see, the concepts of photoelectricity and fluorescence, and one of nature's most basic forces, electromagnetism, to name just a few.

This unique combination of what, on first glance, would seem to be disparate properties, has produced one of the most powerful tools for change ever created. No worthwhile appraisal of the latter half of the 20th century will ever be complete without a thorough discussion of television and its impact on the course of human events during that time.

The Building Blocks of Television Broadcasting

Before any detailed discussion can take place describing just how pictures and sound can be created, transmitted and received almost simultaneously, a few basic terms and concepts should be reviewed.

Television's transformation into the world's premier communication tool is centered around three fundamental developments. First was the discovery of how a picture could be created electronically. Next was the development of how those electronic pictures could be transmitted. Third was the creation of a machine that could turn that electronic signal back into a picture.

These three developments, in turn, were based on two scientific effects and the invention of one piece of equipment where they both could take place. The first effect is photoelectricity, which is how a television camera acquires a picture. Based on the discovery in 1873 that selenium possessed photoelectric properties, this effect is based on the fact that when a ray of light hits a particular substance it produces electrical impulses that are directly proportional in power or strength to the intensity of that light.

The second effect, which was also developed in the 1800's, revolves around what is called fluorescence. Essentially just the opposite of photoelectricity, fluorescence occurs when electrical currents or impulses hit a fluorescent substance and cause it to glow with an intensity that is directly proportional to the strength of those electrical impulses. This effect produces the picture we see on our televisions today.

In order that these two effects could be used to produce a television picture, someone had to design a piece of equipment where they could both be generated and controlled. In 1878, Karl Braun came up with the first crude cathode-ray tube. Roughly 10 years later, Braun established the foundation for controlling photoelectricity and fluorescence when he was able to generate a stream of electrons in his tube that could be moved back and forth with an array of magnets.

Two other principles, dissection and scanning, were also crucial in the development of modern television. Joseph May's experiments with selenium in the late 1800's established the fact that transmission of a picture was impossible unless it could be broken up and sent in pieces. Instead of trying to create a picture on one big cell of selenium, May found out that by creating a mosaic of tiny selenium cells that were connected to a bank of lights, he could focus a design on the cells and reproduce that design on the array of attached lights.

While dissection is crucial to producing a picture, a technique had to be developed where a picture could be picked up one piece at a time, with each piece being transmitted separately and in order so that it could be put back together in a receiver. This technique, scanning, began with the work of a German engineer, Paul Nipkow in 1884. Electron guns in today's televisions are a direct descendant of his important work.

Dissection and scanning also deal in two important concepts for photographic systems like television broadcasting. One concept is that most photographic systems are based on the idea of breaking an image down into minute picture elements or pixels. Secondly, these pixels and their eventual size, determine a picture's resolution or fineness of detail.

All these effects, concepts, principles and equipment are based on how humans actually see. It wasn't until the 11th century that a basic precept of vision, radical at the time, was even considered. That's when an Arabic scientist, Alhazen, defied popular belief by theorizing humans see, not by sending out rays from their eyes, but instead by receiving rays of light reflected off objects.

Both television and motion pictures take advantage of a peculiar physical reaction in the human eye called persistence of vision. This occurs because the retina of the eye keeps an image of an object for just a moment before it fades. As a result, a series of overlapping freeze-frame pictures is perceived as a seamless flow of motion in the mind's eye when humans view a rapid series of static pictures depicting progressive movement. The very basis of television is predicated on the human's persistence of vision to bring together or mentally blend individual pixel sequences into a complete moving image.

A Picture Is Worth a Thousand Words

Although television started out delivering black-and-white images, color broadcasting has become the norm today. Therefore the following discussion on how television actually works will be based on color broadcasting transmission and reception, which were purposely designed to be compatible with existing black-and-white televisions in the late 1950's and early 1960's.

Today's modern television cameras use a variety of devices and circuits to produce the images we see. The major components include a lens, an array of mirrors, camera tubes and the electronic circuits that make it all work.

The lens, like the one in the human eye, gathers and directs (focuses) the light from a particular scene to produce a sharp, full-color image. In order to produce color signals for transmission to a television receiver, the full-color image must first be broken down into the three primary colors — red, blue and green. It is combinations of these colors, in a vast array of intensities, that can produce any color in the visible light spectrum.

The separation of colors is accomplished by a set of three dichroic (light sensitive) mirrors. The first mirror directly behind the lens stops and deflects all blue light from the incoming image. The red and green lights from the image continue on through the first mirror. A second mirror deflects the red light, while the green light continues on its own path.

Each of the primary color streams are fed into their own camera to convert the light into an electronic video signal. These cameras or pick-up tubes have grown increasingly sophisticated over the years. The first such tube was called an iconoscope. It was replaced by image orthicons. The orthicons were eventually replaced with newer technology. Today vidicons, plumbicons and solid state, charge coupled devices (CCD) are in wide use. Yet, despite the increasing advances in technology, the basic functions of the camera tubes have remained essentially constant.

At the front of the tube (facing the incoming light) is the faceplate. A transparent coating on the back of the faceplate is called the signal plate. Just behind the signal plate is a layer of photoconductive material called the target. When exposed to light, the target conducts electricity. At the other end of the tube opposite these structures is an electron gun.

As the incoming light beam passes through the faceplate and signal plate, it causes negatively charged electrons in the photoconductive material to shift toward the signal plate. These departing negative electrons leave a positive electric charge on the target. The positive-charged image on the target corresponds to the incoming image with the brightest parts of the image retaining the highest positive charge on the target's back.

This is when the electron gun begins shooting a beam of electrons back and forth across the back of the target. This is called the scanning pattern. For clarity's sake, a discussion of what actually happens during the scanning will take place first, followed by an explanation of the strict pattern the scanning follows.

Because particles of opposite electrical charge attract, the portions of the image on the back of the target that have the strongest positive charge will receive the most electrons from the scanning beam. As the electron gun's beam moves through the image on the target, a corresponding electrical current begins flowing in the signal plate. The current voltage changes according to that portion of the target image the electron beam is covering at that particular moment. It's this changing voltage that becomes the video signal.

The pattern of the electron gun's scanning is very precise and fast. The scanning pattern splits the image on the back of the target into two fields, with the complete image constituting what's called a frame. Known as interlace or offset scanning, the beam scans the image left to right, from top to bottom, skipping every other line. The odd-numbered lines (1, 3, 5, etc.) are scanned first, then the beam zooms back to the top and scans the even-numbers lines (2, 4, 6, etc.).

This scanning pattern was maintained in the mid-1950's when the television industry was converting to color broadcasting and wanted to establish a new industry standard for transmission and reception of color signals that was also compatible with the black-and-white television sets that dominated the market at that time. The National Television Systems Committee (NTSC) devised what became known as the NTSC color system.

It consists of splitting any given image or frame into 525 vertical scanning lines as did black and white broadcasts. As described above, the electron gun scans those lines on an odd-even basis (262.5 lines per field). One scanned image produces nearly 130,000 picture elements (pixels) per frame. The electron gun is extremely fast, scanning 30 frames per second.

However, for color broadcasts, the video signals from each of the three tubes are fed through designated circuits so that they can be amplified before they're sent on to the encoder. In the encoder the three signals are combined and reformed to produce a compatible color signal in the matrix circuit. This is done by producing two signals that are based not on color but on the three characteristics of visible light.

Two characteristics, hue and chroma, are combined to form a chrominance signal. Hue is determined by the dominant wavelength of each color signal and operates on the concept that an object is essentially red, blue or green (or a mixture of any two of them). Chroma, meanwhile, is the measure of how much a primary color in any given image is diluted with white. For example, chroma would determine the difference between red and pink, or primary blue and sky blue.

The encoder also produces a luminance (or brightness) signal from the combined three color signals. As an optical effect, luminance is separate from color and is based on the total wavelength intensity of light. In the encoder, the luminance signal reflects the percentage of brightness each of the color signals brings to the total intensity of a particular image. This signal, which also produces pictures in black-and-white television receivers, solves the NTSC color/black and white compatibility problem.

Once generated, the chrominance and luminance signals are combined and the encoder adds what is called a color burst and a synchronization signal to the mix. The color burst enables color televisions to separate the color information in the chrominance signal upon reception. The synchronization signal brings the receiving television set into line with the scanning pattern of the transmitted signal.

Putting Sight and Sound Over the Airwaves

While a particular image is being converted into an electric signal in the camera, the sound from that scene is also being processed. These two signals will begin their journey to a television set by using one of the basic forces of nature — electromagnetism.

There are four fundamental forces in nature. Two deal with the relationships of atomic and sub-atomic particles. A third, gravity, is more familiar to most people. The fourth, electromagnetism, while somewhat more obscure, is no less important. It's what makes radio and all other forms of wireless communications possible.

Simply put, electromagnetism is based on two concepts: electric currents produce magnetic fields, and changing magnetic fields produce electric fields. These electric and magnetic forces, in turn, produce an oscillation (a back and forth movement) of electric charges. These oscillations occur in a predictable pattern as electromagnetic waves that fluctuate with alternating peaks and troughs. The measured distance from the crest of one wave to the crest of the next is the wavelength of that particular electromagnetic wave.

The electromagnetic spectrum is made up of bands of different wavelengths, most of which are invisible. These include (from shortest to longest wavelength) gamma rays, x rays, ultraviolet light, visible light, infrared rays and radio waves. These waves also have distinctive frequencies, that is, the total number of individual wavelike motions (cycles) produced each second, which are measured in Hertz (Hz).

Electromagnetic waves in the spectrum run from the shortest wavelengths imaginable (gamma rays have a wavelength less than 1 trillionth of a meter in length with a 100 sextillion Hertz frequency), to fairly substantial wavelengths (some radio waves have wavelengths of more than 6,200 miles). The most common units of frequency when talking about waves in the radio band include kilohertz (kHz - thousands), megahertz (MHz - millions) and gigahertz (GHz - billions). Radio waves can be found on the lower frequency/longer wavelength end of the spectrum, running (relatively) from extremely high (300 gigahertz) to extremely low (30 hertz) frequencies.

Before any television broadcasts or wireless communications can take place, the sounds to be transmitted (whether from a drama, a symphony orchestra or a major sporting event) must be converted into an electric audio signal.

The key tool here is the common, everyday microphone. Generally there are two types of microphones: a dynamic or moving coil microphone and a capacitor or condenser microphone. For the sake of this discussion, the moving coil type will suffice.

Underneath its wire mesh dome, the moving coil microphone has a small, delicate disk or diaphragm that is, in turn, attached to a wire coil. The diaphragm vibrates at the same frequency or speed as the incoming sounds. The oscillating disk then transfers its vibrations to the coil whose base is situated near a magnet. It's this movement of the coil near the magnet that produces an electric current.

This newly formed electric current, based on the specific vibrations of the sounds being fed into the microphone, becomes the sound signal as it begins its broadcast journey.

Video and audio signals by themselves are not strong enough to be transmitted any great distance. This is accomplished by piggy-backing the audio and video signals onto continuous carrier waves through a process called modulation. There are two ways to accomplish this task, either through amplitude modulation (AM) or frequency modulation (FM). Both processes are used in broadcasting a complete television signal.

Amplitude modulation is used in transporting the video portion of the transmission. In this process, the high frequency carrier wave has its amplitude (or intensity) altered to mimic the amplitude pattern of the video wave it's carrying. The stronger carrier wave is made to duplicate the video signal's highs and lows in amplitude. The combined video signal then has its power amplified anywhere from 1,000 to 100,000 watts.

Frequency modulation is used in sending the audio portion of the television signal. In this process the carrier wave's amplitude remains constant. Instead, the carrier wave's frequency is modulated or changed to match the pattern of the audio wave it is carrying. As the audio signal continuously fluctuates or oscillates from strong to weak and back again, the carrier wave's frequency increases or decreases accordingly.

Because of the relatively large amount of information that's carried on a television signal, especially when compared to radio signals, TV signals occupy a fairly wide band or channel in the electromagnetic spectrum. Television channels can be up to 6 MHz wide (6,000,000 cycles per second) in the VHF (30-300 MHz) or UHF (300-3,000 MHz) bands of the spectrum.

The high-frequency carrier waves used in television signal transmission do not follow the Earth's curve as do lower frequency waves used in radio signal transmission. Television antennas broadcast their signal in a direct or line-of-sight manner. Depending on the surrounding terrain and the height of the broadcast antenna, these signals can reach anywhere from 65 miles to 150 miles. Television broadcasters also take advantage of relay stations, satellites and cable networks to get their signal distributed.

On the Receiving End

Not surprisingly, a television set acts much like a television camera in reverse to process the incoming signal. At its most basic, television reception equipment consists of an antenna, a tuner, a variety of amplifiers and separators, and finally, a picture tube to display the end product .

The antenna, by its very nature, picks up any and all signals that it is sensitive to that happen to be flying by at the moment. The tuner allows viewers to narrow their set's focus on a specific frequency or channel. Once the selected signal has been isolated by the tuner, the chosen signal is fed into a variety of electronic circuits that amplify and process the video and sound signals.

The speaker responds to the audio signal much like the microphone, but in reverse. It too consists of a magnet and a wire coil called the voice coil. This coil is attached to the speaker cone which is usually made of very thin paper. The amplified electric current passes through the coil and produces oscillations against the magnet's field. These oscillations make vibrations in the thin paper cone that recreate the sounds first picked up by the microphone just milliseconds before in the television studio.

Meanwhile, the television set has some specific circuits that use the transmitted color burst to separate the chrominance and luminance portions of the video signal. These newly separated signals are then processed by another set of circuits, collectively called the decoder or matrix, that break them down to the original red, green and blue (RGB) signals produced by the camera. These three signals are then fed into the three-element picture tube to reconstruct the total color image.

As the three light signals enter the picture tube, the synchronization signal, that was also broadcast with the combined television signal, is directed to deflection plates or coils placed around the narrow neck of the picture tube. These coils will synchronize the scanning of the picture tube's three electron guns with those that produced the signal. The three guns are usually spaced 120 degrees apart around the central axis of the picture tube neck.

The electron guns face a shadow mask situated in front of the television screen. The mask is usually a thin metal plate perforated with approximately 200,000 carefully positioned holes. This mask acts as a guide for light beams produced by the electron guns. Just behind the mask is a metal-coated phosphor-dot plate which is essentially the backside of the television screen itself. This plate consists of roughly 600,000 phosphor dots situated in triangular groupings or trios with one dot for each color in a group.

The holes of the shadow mask are precisely arranged so that the appropriate color beam hits the right phosphor dot at the right angle at any given time during a scanning run. Again, the scanning repeats the cycle established in the camera, that is, odd and even numbered lines combined to produce a full frame of the transmitted image. And, because the dots are so very, very close to each other, the eye sees a blended, full-color image.

What's Next?

The future of television is wide open. It's being reshaped on an almost daily basis. The advent of the cable industry, and direct broadcast satellites165 and receivers are changing what and how we receive. The gathering momentum for wide-screen, high definition television (HDTV) with its theater quality pictures (operating on the order of 1,000-line frames) and the digital revolution in sound and video production and transmission will change the quality of the pictures and sound we'll be receiving.

Hang on to your remote controls. The fun, and the technologies to produce it, have just begun.

u contributed by Michael C. Lafferty

Broadcast Television Industry

During the last 20 years, the broadcast television industry has undergone basic, and in some ways, drastic change. Sometimes that change has come from within, but more often, it's come about because of outside forces and developments. The corporate ownership changes of the three major networks in the mid-1980's, the surge in the availability and popularity of cable television, as well as the increased accessibility and use of satellites by local stations, have altered network-affiliate relationships in fundamental ways. Yet, despite the upheavals, the predicted demise of one or more broadcast networks has not come about. In fact, with deregulation moves well underway in Washington, D.C., many observers predict the television broadcast industry will be a major player in the coming interactive communications age.

The Network-Affiliate Relationship: A More Balanced Partnership
At the heart of broadcast television industry organization is the network-affiliate relationship. Nearly 70 percent of all commercial television stations in the United States are affiliated with one of the three major networks. Only the top three networks — American Broadcasting Company (ABC), CBS, Inc. and National Broadcasting Company (NBC) — own enough stations for each to reach more than 20 percent of U.S. television homes. There are also more than 100 other networks, many of which operate part-time on a regional or special-event basis. They often provide programs of a particular kind, such as sports or religion, or programs in other languages, most notably in Spanish.

Yet, the evolution of the major network-affiliate relationship from its birth in the late 1940's to today is much like the reversal of roles that parents and children go through as elderly adults look towards their grown children for support in later years.

When television broadcasting began in earnest in 1948, television networks assumed the almost paternalistic role they had established as radio networks with their radio affiliates in the 1930's and early 1940's. The networks provided the affiliates with top-notch programs that attracted big audiences, which in turn, attracted big advertisers. Not only did the affiliate gain the stature of being associated with one of the big three, it got paid (network compensation) to air those network shows.

While direct network compensation usually totals less than 10 percent of an affiliate's annual income, the affiliate can also cash in on network programs on a barter system. With certain shows, the network will make selected advertising time available for the affiliates to sell locally at premium prices.

When the broadcast networks as a whole reached a vast majority of the prime time viewing audience (at their peak, reaching more than 90 percent of the audience), everything was fine. Both the networks and their affiliates were making substantial money. But things began to change in the late 1970's and even more so in the 1980's.

The growing popularity of cable television began to cut into broadcast television's market share. (Today, the three major networks together reach about 60 percent of the total TV households in the United States.) In addition, the rising costs of production and regulatory restrictions on the broadcast network's ability to produce and syndicate shows began limiting profits. As a result, by the mid-1980's, both the networks and the affiliates began to squabble about network compensation rates. The networks wanted to cut the rates; the affiliates felt the audience access they provided was grossly undervalued.

At first, NBC gave in to affiliate pressure and increased its compensation rates. Then, in a 1989 reversal, NBC tightened its criteria for affiliate payments by focusing in on how much of the local audience an affiliate actually delivered. Meanwhile, CBS and ABC reduced their affiliates' compensation as well. The networks also claimed more of the advertising time during network programming.

The affiliates retaliated the best way they knew how, by preempting more network programming. With the start of the prime time access rule (PTAR) in 1971, which limited network shows during prime time, the sources for independent programming exploded. PTAR was designed to increase and diversify local programming and it largely succeeded. By the time broadcast television was reeling from the economic crunch in the late 1980's, affiliates had a host of programming choices.

With many syndication hits available, like *Entertainment Tonight* and *Star Trek: The Next Generation*, as well as a slew of game shows like *Wheel of Fortune* and tabloid news programs like *Inside Edition*, affiliates have been able to boost their market share without being totally dependent on network programming. The networks, in turn, have lost in the tens of millions of dollars in revenues.

The network-affiliate relationship has also undergone a change in another important programming area: news. In the past, one of the biggest benefits of having a network affiliation was the ability to be connected to a vast international news gathering and distribution system. But advancing technology, especially in the development of satellite communications and minicams, as well as spiraling network news production costs, have broken the spell of the network's news gathering power.

Today, an increasing number of local stations, affiliates and independents alike, subscribe to cooperative satellite broadcasting systems as the sole source of or a supplement to their news-gathering capabilities. Often, in return for news feeds that cover regional, national and international events, the participating stations contribute to the satellite video pool when news breaks in their particular area.

As a result of these cooperatives and the slashing of news staffs and budgets at all three major broadcast networks, the networks have come up with their own cooperatives. Each network has its own satellite distribution system. At ABC it's ABSAT, CBS has NewsNet and NBC offers Starcom. In return, the increasingly sophisticated local stations act, in effect, as news correspondents for the networks when newsworthy events happen in their local broadcast area.

Major Changes in Network Ownership
Despite their steady loss of market share in the 1980's, the three major networks became prime takeover targets. The loss of audience was, in many investors' minds, offset by the continuing rise in commercial advertising rates. In addition, the Federal Communications Commission (FCC), in a major push for deregulation, relaxed or eliminated a number of regulations that made television station ownership easier and more attractive.

Under the stewardship of the FCC chairman appointed by President Ronald Reagan, the agency de-emphasized the concept that station owners were keepers of an established public trust. Instead, the FCC took the view that the public interest would best be served by a competitive marketplace with a minimum of governmental regulation.

The agency continued to streamline the renewal process and eliminated policies that detailed procedures for licensees to research the public's needs in their broadcast area and formulate detailed plans for how their stations were going to meet those needs. Among other things, the FCC also dropped time constraints on how long a station had to be owned before it could be sold again and increased the number of stations one person or company could own (from 7 TV, AM and FM radio stations to 12 stations in each service).

During the 1980's, hostile takeovers and leveraged buyouts (LBOs) were frequent on Wall Street. It was only a matter of time before these financial forces and industry changes focused investor attention on the big three networks. Unfortunately, the network's last line of defense against such takeovers, the legendary founders like CBS's William Paley and NBC's David Sarnoff, were basically out of the picture by that time.

The first change in ownership has proven to be the most successful. In March 1985 it was announced that Capital City Communications (Cap Cities) would acquire ABC in a deal valued at $3.5 billion. What made this merger unique was that, in terms of real assets (stations, production facilities, staff, etc.), the company being taken over (ABC) dwarfed the company that was buying it (Cap Cities).

But the merger had two things going for it. First, it was between two communication companies. Second, Cap Cities' financial strength, with its stock valued at $200 a share, was a real boost for the network, whose stock was valued at under $20 a share.

The deal became a reality in January 1986. Shortly thereafter, Cap Cities' executives brought their "lean, mean" management style to bear on a bloated network that hadn't yet faced up to the fundamental changes that were taking place in the marketplace. Deep cost-cutting measures soon led to huge layoffs and a massive reshuffling of people and priorities.

The ABC/Cap Cities deal seemed to have a domino effect. A few weeks after it was announced, Ted Turner, the cable TV entrepreneur, made an unfriendly takeover bid for CBS. The complicated maneuver, which was valued at nearly $5 billion, involved a massive "junk bond" (high-risk debt securities) and a Turner Broadcasting stock offering. CBS thwarted the bid by going deeply in debt to buy back more than 20 percent of its own stock from the public.

But instead of improving the situation, things only got worse. The massive debt crippled the ailing network. In stepped an apparent white knight in the form of then-minority stock holder, Laurence Tisch, Chairman and Chief Executive of Loews Inc., an entertainment, hospitality and investment conglomerate. Tisch eventually increased his CBS holdings to just under 25 percent of its total stock and assumed a predominant role in the network in late 1985.

The change in leadership and the network's huge debt brought widespread changes at CBS. A major cost-cutting program, with resulting staff cuts, was put into place. To service the debt and implement a new broadcast-only strategy, the company's long-standing diversification program was halted with divestiture of CBS holdings in major film production, toy manufacturing and publishing ventures. Then, in 1988, to further focus CBS energies on broadcasting, Tisch brokered the $2 billion sale of the world's largest record producer, Columbia Records, to Sony Corporation.

Amid all this financial manipulation, a minor miracle occurred. In May 1985, Rupert Murdoch, Australia's best-known media mogul, switched citizenship to comply with an FCC ban on foreign ownership of U.S. broadcasting facilities so that he could start a fourth national network. His ownership of 20th Century Fox film studios and his $2 billion purchase of the Metromedia TV station group (seven independent stations in 10 major markets) gave Murdoch the production and distribution core he needed to launch the Fox Broadcasting Company (Fox) in 1986.

Before 1985 ended, the third and final established network, NBC, was well on its way to switching owners as well. Despite earlier talks with MCA and the Disney Company, RCA finally struck a tentative deal with General Electric (GE) in December 1985. While its NBC subsidiary was then the top-rated network, RCA was suffering from management problems and losses incurred by its unsuccessful bids to expand into computers and videodisks.

The $6.3 billion deal was consummated a year later, and RCA disappeared from America's business landscape. The well-honed corporate culture of GE, the nation's second largest industrial conglomerate, was a big adjustment for NBC. Like the other two networks, a major reorganization and huge staff reductions soon followed the change in ownership. The most jarring symbol of the change came when GE-appointed executives sold the venerable NBC radio network, whose formation had been the catalyst that started America's broadcast industry in 1926.

Broadcast Programming: A Habit That's Hard to Break

Many, if not most, of the program formats that pay the bills in the television broadcast industry did not get their start on the "tube." Most of the programs, like the networks themselves, got their start during the golden days of broadcast radio in the 1920's and 1930's.

While different production techniques had to be perfected to make the transition from radio to television, the basic programming formats were not altered all that much. What follows, therefore, is a brief summary of some of the most enduring program formats that make broadcast television what it is today (as well as what it was originally and probably will be in the future).

Situation Comedies

One of the most popular television program types is the situation comedy, or sitcom, which is an exception to the "it-happened-on-radio-first" rule. The popularity of these half-hour comedies, which found an early home on television, peak and wane like most formats. But, they are always somewhere on the dial.

Sitcoms, depending on their specific premise, involve one or more regular characters who are put in generally absurd, often marginally believable, situations. While these situations or the progression of a particular episode may be unpredictable at times, the real humor comes from the predictable way the characters react to a particular situation. *I Love Lucy*, *The Mary Tyler Moore Show*, *The Bob Newhart Show* and *Home Improvement* are prime examples.

Variations on the theme include: traditional family sitcoms (*The Cosby Show*, *Family Matters*), "reality-based" family sitcoms (*All in the Family*, *Roseanne*), ensemble sitcoms (*M*A*S*H*, *Cheers*), nontraditional "family" sitcoms (*Seinfeld, Wings*), police sitcoms (*Barney Miller*), fantasy sitcoms (*Bewitched*) and musical sitcoms (*The Monkees*, *The Partridge Family*).

Sitcoms are particularly valuable to networks as first-run shows and to local stations as syndicated reruns because they appeal to a key demographic market, women 18-49 years old. This is particularly important because these half-hour comedies tend to get higher ratings than hour-long shows, with hit sitcoms attracting as much as 30-40 percent of a given audience.

Dramatic Series

This is a wide-ranging programming category with many variations. The basic premise of any television dramatic series, depending on its particular twist, is to depict a leading character (or an ensemble cast of characters) having to deal with a specific (and preferably dramatic) problem.

If it includes a bunch of cowboys or "claim jumpers," it's a western drama. In fact in 1959, action-packed westerns were so popular there were 32 of them broadcast during that season alone. Known as "horse operas" and "oaters" by critics, westerns all but disappeared from the tube by 1975. Not only did they entertain several generations of TV viewers, but they also gave a number of stars their big break. Oater graduates include: Steve McQueen (*Wanted: Dead or Alive*), Clint Eastwood (*Rawhide*), James Garner (*Maverick*), James Arness and Dennis Weaver (*Gunsmoke*) and Michael Landon (*Bonanza*). By the early 1990's, the western had started to make a comeback with such series as *The Young Riders*, *Dr. Quinn: Medicine Woman* and *Hawkeye*.

An even more enduring drama format is the crime/police drama series. Variations within this format are hard to keep up with. They range from the sparse and mono-dramatic tones of *Dragnet* in the 1950's, to the cool and calculating *Perry Mason* in the 1960's, to the often humorous mind teasers of *Colombo* in the 1970's, to the gutsy realism of *Hill Street Blues* in the 1980's, and to the provocative, "viewer-discretion-is-advised" *N.Y.P.D. Blue* of the 1990's.

Another drama format, appropriately enough, keeps coming back to life periodically. Hospital or medical dramas, since they deal with life and death issues, have always had a strong appeal to America's television audiences. Strangely enough, they often seem to arrive in pairs. *Ben Casey, MD* and *Dr. Kildare* went at it scalpel and suture in broadcast television's heyday during the 1960's. Later in the 1970's, *Dr. Welby, MD* and eventually the ensemble cast of *St. Elsewhere* in the 1980's kept viewer attention on the operating table. More recently in the 1990's, *E.R.* and *Chicago Hope* have brought medical patients and pandemonium back into viewing popularity.

Movies and Miniseries

When broadcast television first hit the airwaves in the late 1940's, Hollywood shut its doors and its film vaults to the threatening new media. Eventually, only those movies made before 1948 were licensed to be shown on the tube.

As television started to rely more and more on Hollywood to help produce television shows, Hollywood soon got over its fear of being replaced by TV. And after 1960, when the studios started licensing movies made after 1948, Hollywood found it had a whole new profit center sitting in its film vaults.

By the 1970's, the networks were in fierce bidding wars for Hollywood classics and popular hits. In 1976, *Gone With the Wind* earned a cool $5 million for one showing on NBC. In the mid 1980's, ABC coughed up a record $15 million for the right to show *Ghostbusters*. Yet, by the end of the decade, with increasing competition from cable movie channels and home VCRs, the licensing fees for Hollywood movies had finally leveled off, averaging $5 million or less for one-time broadcasts.

However, Hollywood blockbusters still get the network nod (and big bucks), especially during broadcast television's sweeps weeks in February and May. This is when television rating services collect viewing data that's used to set television advertising rates across the country. Big Hollywood movies are a sure way for networks and their affiliates to garner big chunks of the viewing audience and higher ad rates.

The leveling off of licensing fees for Hollywood movies also helped create another product, made-for-TV movies, many of which were eventually produced by Hollywood studios. TV network executives realized as early as the mid-1960's that there would soon be a supply-and-demand problem with Hollywood's theatrical movies. In addition, many of Hollywood's movies just couldn't be shown on TV at that time due to what was then considered their "adult" content.

NBC led the way by working with Universal Studios to produce movies specifically for its *World Premier* anthology. ABC followed with its highly successful 90-minute *Movie of the Week* series. Over the years, the quality and number of made-for-TV movies has increased dramatically. So much so, that by 1990 nearly two-thirds of the movies shown on the networks were tailor-made for television.

In the miniseries format, however, ABC took the lead. These special made-for-TV movies, usually 8 to 12 hours in length, are shown over an extended schedule of four to six evenings. ABC's first endeavor in 1976, *Rich Man, Poor Man*, drew a large audience. But, its second effort in 1977, *Roots*, a 14-hour saga of African-American history through one family's perspective, made broadcast history by setting audience share records. Since then, miniseries have become standard fare and a common way for networks to wage ratings warfare with such popular offerings as *Shogun* (1980/NBC), *The Thornbirds* (1983/ABC), *Lonesome Dove* (1989/CBS) and *The Stand* (1994/ABC).

Sports

Given the American penchant for all things competitive, it's no surprise that sports have been a big hit since the earliest days of television. In fact, the 1947 World Series was one of television's first broadcasts and a big catalyst in boosting consumer demand for TV sets. For the sports teams, the networks and the advertisers, it's been pretty much a winning season ever since.

Sports broadcasting got a significant boost when ABC latched onto it in the late 1960's to help the perennial "also-ran" network distinguish itself from its more popular competitors. Its groundbreaking sports anthology series, *Wide World of Sports*, shifted its coverage over a number of different sporting events during each show, thereby combating viewer boredom generated by extended coverage of just one event or game. This panorama format also helped provide coverage of a wider variety of sports, like surfing or cliff diving, which had received little or no network time before.

ABC, in its drive to make a difference, was the first network to take sports coverage out of its recognized time slots, which centered around weekends and occasional weekday afternoons. In 1970, ABC launched *Monday Night Football* with Howard Cosell. This unique sportscast laid the groundwork for prime time coverage of major sporting events. It also caused significant rule changes, in a number of sports, to accommodate the broadcasting and advertising needs of television (for example, the two-minute end-of-game warning in professional football).

Over the last three decades, the balance of sports coverage has shifted significantly. During the 1960's, ABC carried the lion's share of sports programming with coverage of professional basketball and football, college football and the Olympics. NBC made a major bid for sports primacy during the 1970's and the 1980's with key bids to cover the Summer Olympics, college basketball and professional baseball.

CBS finally entered the game big time during the early 1990's, outbidding its competitors for Olympic coverage; professional baseball, basketball and football; and college basketball and football. Even the new kid on the broadcasting block, the Fox Broadcasting Co., got into the game in 1994 when it stunned the industry by outbidding CBS with a $1.6 billion deal for exclusive coverage of NFL games for four years.

Aggressive competition from the cable industry, however, has forced the networks to regroup their sports coverage to some extent. ABC led the way by becoming an active participant in the cable industry with its purchase of 80 percent of ESPN, the all-sports cable network. The broadcast networks as a whole have been focusing more selectively on super events, like college and professional playoffs and championships. They've also sought exclusive rights to regular season competition, thereby eliminating regional and local coverage that would compete with network coverage.

Sticks and Stones — Taking Aim at Broadcast Television

There's one thing the broadcast television industry has always had in abundance...critics. From its earliest broadcasts to the present day, the "boob tube" has been a lightning rod for criticism from media observers, politicians and people from all walks of life. While there are continuing debates about the proper role of broadcast TV in today's society and the amount of regulation the industry needs, in large part, the most vehement battles have centered around network programming practices.

What follows is a brief synopsis of some key areas of contention that will continue to attract viewer notice and keep network TV executives on their toes for a long time to come. While one area is more far-reaching and less amenable to specific remedies, it continues to generate heated debate in all its various facets. The other, while no less hot a topic, has gotten some action in Washington, D.C., and some changes from the networks themselves.

Taking The Path of The Highest Ratings

Since network broadcasting is a commercial operation, critics have often attacked the industry's penchant for appealing to the lowest common denominator to get the broadest possible audience for its advertisers. This brazen appeal for high ratings, so the critics say, produces programs that rarely, if ever, challenge viewer intellect or promote discussion of relevant issues.

In fact, this argument encompasses a whole range of heated debates in the broadcasting industry. This includes such issues as gratuitous violence; obscenity, both visual and aural; the upsurge in tabloid news shows and the apparent death of the television documentary; and calculated shock topics that are usually accompanied by "let-it-all-hang-out" discussions on talk shows, just to name a few.

The most famous criticism in this area came from then-FCC Chairman Newton Minow in 1961. In a speech before the National Association of Broadcasters (NAB), Minow challenged broadcast executives to actually sit in front of their televisions for a day and take a look at what they were dishing out to the American public. Minow assured them that what they would find was a "vast wasteland." That wasteland, according to Minow, was made up of an endless line of shows that contained unacceptable levels of "blood and thunder, mayhem, violence, sadism, murder...private eyes, gangsters, more violence, and cartoons. And endlessly, commercials — many screaming, cajoling, and offending."

Some 15 years later, Minow appeared before the NAB once again and said his famous vast wasteland comment was pretty much on the mark. And, while Minow told the executives that he had seen considerable improvement over the years, especially in news and information, other critics still believe network television has a long way to go in this area. Obviously, with increasing competition from the more daring and free-wheeling cable channels, the broadcast networks will feel more and more pressure to match them at their best...and more than likely at their worst as well.

TV and Children — Big Market, Big Responsibilities

As pervasive as it is today, children's programming was not considered important when television first started. Advertisers believed TV was too expensive and the children's market not that lucrative. This was particularly true in the 1950's, when many programs had only one or two sponsors.

By the mid-1960's, participation advertising, in which programs had multiple sponsors, became the rule, however, and advertisers discovered there were big bucks to be made in the children's market. That market, it was soon discovered, also could be isolated and bombarded on Saturday mornings, when ad rates were cheaper, too.

The networks responded by offering a whole slate of cheaply produced animated shows that were repeated continuously. As competition grew more intense, the shows grew more sensational and violent, with a host of grotesque characters, monsters and assorted mayhem designed to snare the wide-eyed wonder of children. Of course, it didn't hurt, either, that the commercial time on Saturday morning ran at 16 minutes per hour, versus normal prime time that ran a mere 9.5 minutes per hour.

Finally, the ire of parents and concerned groups like Action for Children's Television (ACT) raised the hackles of network executives and the consciousness of elected representatives and appointed officials. Their reform efforts were boosted enormously in 1969, when *Sesame Street* took to the public airwaves and showed how children's television could both educate and be fun. Other shows like *Mister Roger's Neighborhood* and *The Electric Company* reinforced the concept.

Such pressure finally started getting results when the networks dropped commercial time on Saturday mornings from 16 minutes per hour to 9.5 minutes. Children's shows also featured less violence, and advertising codes were tightened. The networks themselves got on the bandwagon and started to develop shows like *Fat Albert and The Cosby Kids*.

However, in the 1980's, with the big three networks earning roughly 3 percent of their revenues on Saturday mornings (approximately $250 million in total), they came up with a new way to cash in on kids...product licensing. With such shows as *The Smurfs*, *Strawberry Shortcake* and *My Little Ponies*, the networks hit a virtual gold mine of added revenue in developing a host of toys and other character-related paraphernalia. Some of the shows, in effect, became 30-minute commercials with still other commercials sprinkled throughout. Character licensed products, in fact, earned $65 billion in 1990 alone.

Of course, the flip side of the coin was that product licensing has been a boon to such shows as *Sesame Street* as well. In fact, it has been estimated that more than two-thirds of the cost of producing and airing such shows is recovered by licensing revenues.

ACT and other concerned groups and individuals took their case against this non-stop hucksterism to Washington. The result was the Children's Television Act of 1990. The act set limits on the how much time could be devoted to commercials during children's programming in both network and cable industries. It also stipulated that operators air a minimal amount of programming that would meet the "educational and informational needs" of their half-pint audiences. Regardless of the legislative effort, product licensing from children's shows is still big business, as the recent success of *The Teenage Mutant Ninja Turtles* and *The Mighty Morphin Power Rangers* attest.

The effort to protect the impressionable psyches of America's children is an ongoing battle. Individuals and watchdog groups like ACT continue to monitor the good, the bad and the potentially harmful programming that's being created and aired on television, broadcast and cable alike. As long as there are children to be entertained and educated and advertisers' products to be seen and sold, a natural tension will keep the debate going for generations to come.

Broadcast Television Adjusts to Future Shock

For the past two decades, broadcast television has gone through major upheavals, both within the networks themselves and the industry in general. Outside forces, like cable television and direct broadcast satellite, continue to pressure the networks into rethinking their programming priorities. Lawmakers' growing hands-off attitude portends a fairly free-wheeling marketplace that may enhance the networks' ability to compete.

Whatever the effect on the amount of regulation or on the networks' ability to exploit new technology, one fact is certain. The broadcast networks are here to stay (possibly with some new owners), and they're going to be major players in the ongoing information revolution.

u contributed by Michael C. Lafferty

Electronic Bulletin Board Systems (BBS)

Electronic bulletin boards are computerized systems that allow users to communicate, leave messages and share computer programs and other information with other users of the system.

The first electronic bulletin board systems (BBS's) were developed in the 1960's by the federal government for use on the military's interconnected mainframe computers. Because the system was developed for the military, only members of the armed forces or people who had a direct link to one of the mainframes could access the system.

As low-cost personal computers became popular in the 1970's, users looked for ways they could share information about their systems. On-line networks became possible as more efficient data translation and transmission systems were developed. These early networks were primarily the domain of computer hobbyists, who used them to exchange information about new technologies and applications. Hobbyists also used the networks for exchanging the newest software, and access to noncommercial, public domain programs remains a hallmark of BBS systems to this day.

BBS's are similar to electronic mail (E-mail) systems. However, unlike E-mail systems, which usually protect messages intended for individuals from other users of the system, messages posted on BBS's are available to anyone who logs on to the system. Users can also browse through selected categories of messages posted by others.

At the heart of every BBS is a main computer. One or several modems, as well as a large hard disk for data and message storage, complete the basic setup. Special communications software, called bulletin board software, enables the system to log in users as they call and maintains a database of files and messages.

BBS's are greatly automated, but they still require a human touch. System operators, or sysops, watch the systems for any problems, provide assistance to members, and watch for any copyrighted software that might appear on the system. Although advances in bulletin board software make BBS's appear fairly sophisticated, many of them are still run from the sysop's home, and consist of no more than a personal computer linked up to a few modems.

Many BBS's start as hobbies and charge low or no service fees. Often, these BBS's are open to all; however some are available only to members of specific organizations. Businesses also establish BBS's for communicating with employees and clients. Bulletin boards are also a feature of many commercial on-line systems such as America Online (AOL), GEnie, CompuServe and Prodigy.

Industry experts estimate that there are approximately 60,000 BBS's currently in operation in the U.S., catering to some 18 million people. It is possible to find a BBS that focuses on almost every topic imaginable, ranging from home improvement and repair to an on-line network for fans of the Grateful Dead. Many BBS's are now hooking up to the Internet and may be accessed there as well.

u contributed by Sonia Weiss

Bus

The bus is a communication system that allows components of a computer to share data, locate memory addresses and coordinate computer functions.

A computer is really an assembly of different parts working in coordination with each other. But to do so efficiently, the individual parts must have some way of knowing what the other components are doing. A series of wires, called the bus, allows this to happen. The bus serves as a telephone wire between the components of a computer’s motherboard, which secures many of the computer’s vital organs, such as its microprocessor, main memory, read only memory chips, the clock and expansion boards. Also, the bus is the computer’s way of communicating with external devices such as the keyboard and monitor. The bus carries an array of information including data, memory storage locations, and central processing unit (CPU) commands. The speed with which the bus shares information between these individual parts greatly affects how fast the computer operates. The more wires a bus has, the more information it can send at one time. A 32-bit data bus, for example, contains 32 bus wires and is capable of processing more information at a faster rate than earlier designs containing only 8- or 16-bit buses.

Expansion Bus

If there is one thing the history of computers tells us, it’s that today’s computer will be outclassed by fancier models in a short time. To help the average consumer who cannot afford to buy a brand new computer every time a new computer device arrives on the market, the expansion bus provides a computer room to grow. The expansion bus contains slots into which expansion boards fit, making computers more productive. A computer that was silent suddenly can play music, thanks to a sound board; a computer that originally had little memory can have its capability expanded because of a memory board. Expansion slots are the computer’s link to new technology.

Local Bus

In order to speed up communication between individual expansion boards that have been installed into an expansion bus and the central processing unit, a computer uses a local bus. This allows the CPU to communicate directly with the individual boards instead of sending data through the rest of the expansion bus as well. It also provides a direct link between the central processing unit and the board being used. This link promotes increased speed in areas where rapid data exchange is needed, such as in a video display or in data storage.

u contributed by Christopher LaMorte

Bush, Vannevar (1890 – 1974)

American electrical engineer, government official, educator, scientist and inventor, primarily known for developing the first analog computer — the Differential Analyzer — a forerunner of the modern digital computer.

Bush was born in Everett, Massachusetts, in 1890. He was educated at Tufts College, and received a doctorate in engineering from both Harvard University and the Massachusetts Institute of Technology (MIT). After a short stint working for General Electric in 1913, he taught at Tufts from 1914 to 1917. He then conducted research in submarine detection for the U.S. Navy. From 1919 to 1938, Bush taught engineering at MIT. He also served as Vice President and Dean of Engineering during the last six years of his tenure. While at MIT in 1925, Bush and his coworkers developed the first analog computer, which was designed to solve differential equations. In 1930, a team led by Bush completed the Differential Analyzer, an analog computer designed to rapidly and automatically solve complex mathematical problems.

After leaving MIT, Bush was president of the Carnegie Institution in Washington from 1939 to 1955. On leave from Carnegie during World War II, he directed the newly established U.S. Office of Scientific Research and Development, where he used technology to aid the war effort. Two notable programs he headed include the Manhattan Project's development of the first atomic bomb and the perfection of radar. His earlier invention, the Differential Analyzer, helped calculate wartime artillery trajectories. Bush also devised a Japanese code-breaking machine which the Allies successfully used.

After leaving Carnegie in 1955, Bush returned to MIT, where he remained until retiring in 1971. Although best known for creating the Differential Analyzer, he also developed the Rapid Selector (in collaboration with Ralph Shaw), which addressed the problem of rapid information retrieval via microfilm. Throughout his lifetime he received many awards and honorary degrees for his achievements. Vannevar Bush died in 1974 in Belmont, Massachusetts, at the age of 84.

u contributed by Kay S. Volkema

Bushnell, Nolan Kay (1943 –   )

American business entrepreneur and computer games inventor, best known for founding Atari, Inc. and Pizza Time Theatres and for creating the first commercially successful video game, *Pong*.

Bushnell was born in Clearfield, Utah in 1943. As a boy, he enjoyed watching TV and operating a ham radio, and he did well in school and science fairs. Later, he was educated at Utah State College and the University of Utah, where he majored in electrical engineering and was influenced by Dr. David Evans, a computer graphics pioneer. At the time, Bushnell and many other students were programming college mainframes to play a game called *Space War*, developed in 1962 by two graduates of the Massachusetts Institute of Technology (MIT). During summer breaks, he worked at Lagoon Amusement Park near Salt Lake City, where he learned the business of arcade games.

In 1968, Bushnell obtained his engineering degree. The next year, he moved his wife Paula and two daughters to Santa Clara, California, where he had accepted a job as a research design engineer for Ampex Corporation, a high tech company located in the Silicon Valley. In his spare time, he worked on inventing a video game called *Computer Space,* in which rocket ships battled flying saucers. Because he spent so much time on this pursuit, he and Paula were divorced.

Bushnell left Ampex in 1971 to become a product engineer at Nutting Associates, a coin-operated game manufacturer. He had licensed *Computer Space* to Nutting, but only 1,500 units were sold and it was considered a failure. But he had learned that complicated instructions contributed to his game's unpopularity. He left Nutting the next year.

Bushnell founded his own company to develop video games in 1972. He first called the company Syzygy, then renamed it Atari. His partner was Ted Dabney, an Ampex colleague, and they each contributed $250 to the new venture. Aided by computer engineer Allen Alcorn, they designed their first game called *Pong*, which was manufactured in an old roller rink. It was an immediate success, and Atari sold $13 million worth of units the first year. *Pong* was marketed through traditional distributors of pinball machines and was the first coin-operated game to become wildly popular.

Atari's success grew as new versions of *Pong* were introduced. Then Sears helped sell millions more of the home version over the next few years. Bushnell began hiring other game designers, and Steve Wozniak and Steve Jobs (who would later found Apple Computer, Inc.) collaborated on a game called *Breakout*, which Atari introduced in 1976. In fact, Jobs approached Bushnell about investing in their fledgling company that year, but Bushnell wasn't interested in microcomputers. Atari did $40 million in business in 1976 and was purchased by international entertainment conglomerate Warner Communications for $28 million, with Bushnell personally receiving $15 million and remaining on as Chairman.

Before leaving Atari in 1978 over a failed Video Computing System, Bushnell bought Pizza Time Theatre from Warner for $500,000. Originally Bushnell's idea, Pizza Time was a combination pizza eatery and video game arcade, featuring performing robots. It expanded from seven locations in 1979 to over 200 within three years. But it fell on hard times, and Bushnell resigned from Pizza Time in late 1983, just as it filed for bankruptcy.

During his tenure at Pizza Time, Bushnell also became a venture capitalist and founded Catalyst Technologies and Sente Technologies, Inc. He also co-founded a computer peripherals company called Axlon in 1985 with John Vurich. But by 1986, his venture capital business had also declined and he began collaborating with Steve Wozniak on a toy robot venture.

Currently, Bushnell is Chairman of OCTus, Inc., a networking and personal communication software company located in San Diego.

Nolan Bushnell will be remembered as the inventor of the first commercially successful video game and founder of Atari, which helped spawn a huge new entertainment industry that invaded amusement parks, shopping malls and homes all over America.

u contributed by Kay S. Volkema

Dell Computer Corporation

One of the fastest growing computer companies in the United States, with sales offices in 18 locations throughout the world. Dell Computer is known for its direct sales of computers and other products to the end user. The company holds 11 patents for products it has developed.

Dell Computer Corporation, based in Austin, Texas, was founded in 1983 by Michael S. Dell. Dell, Chairman of the Board and Chief Executive Officer, was born in l965 and began the company as PC's Limited in his dormitory room at the University of Texas at Austin. In l987, he changed the company name to Dell Computer.

From the beginning, the company's goal was to sell computers and related products directly to the end user at a sizable discount. Initially a mail-order company, Dell marketed itself through ads in the local newspapers and later added national computer publications to the mix. The company did so well that Michael Dell dropped out of college when monthly profits reached $80,000.

Shortly thereafter, he began making and marketing his own IBM-style computers. Michael Dell's plan to sell computers and related products directly to the end user and provide quality customer service has made the company a success. It has also earned him the reputation for being an individual who refused to work in the computer industry in traditional ways.

In l987, Dell Computer established its first international subsidiary in Great Britain. Also in that year, it added a field sales force to specifically service large corporate accounts. Throughout the expansion in the late l980's, the company's profits continued to grow. In 1990, due to an oversupply of products and Michael Dell's decision to drop an engineering workstation project, the company's net income dropped 64% to $5 million. This was down $14 million from the previous fiscal year.

In August 1990, in an effort to expand its market share, Dell entered the U.S. retail market through an agreement with CompUSA, which was the country's largest computer superstore network. In November 1992, Dell announced a planned second Dell public offering. This move was expected to raise more than $150 million for four million shares of stock. At the time, a leading stock market analyst named David R. Korus noted Dell's seemingly inappropriate reporting practices for currency hedging. The value of the company's stock dropped 10% based on Mr. Korus's announcement. It also prompted a volatile and bitter rebuttal from Michael Dell. However, in succeeding weeks, the Board of Directors mandated the company stop such "adventurous" trading.

The company withdrew its public offering in February 1993, and announced a lower long-term profit margin goal for the same year. Once again, based on this news, the value of the stock fell 17%.

Through its financial roller coaster ride of the early 1990's, the company continued to implement a variety of tactics to expand its market share. However, in May 1993, the company unexpectedly canceled the launch of a new laptop computer, anticipating that customers would prefer to buy a laptop with a faster 486 chip rather than the 386 that had been used. Subsequent announcements of greatly reduced first quarter profits didn't help investor confidence. Indeed, much of the company's perceived volatility was due, in part, to its explosive growth and quick climb to fifth place in computer sales and uncertainty about management's ability to keep the company in the top five.

In recent years, the company has taken steps to diversify its product lines. In August 1993, Dell launched its own Latitude XP laptop computer. It features a lithium-ion battery made by Sony, which provides much greater use time — as much as 5 to 17 hours — without needing a recharge.

One of Michael Dell's strengths has been his ability to recognize that he needed expert management help in a variety of areas. Since the late 1980's, a number of top-notch officers have been named to key positions at Dell Computer. In 1986, Dell named E. Lee Walker of Austin as President and Chief Operating Officer of the company. Walker worked with Dell from 1986 to 1990, and is credited for mentoring Dell and helping implement his ideas for marketing the company. Walker's successor was Morton H. Meyerson, the former President of Electronic Data Systems Corporation. He remained in the position for approximately one year.

On June l, 1994, Morton Topfer, who previously worked with Motorola for 23 years, joined Dell Computer as co-Chief Executive Officer. Shortly thereafter, Joel Kocher left Dell to join a different organization.

In 1994, Dell Computer also severed its relationship with five retail partners including CompUSA and Best Buy. The company's decision was based on its need to re-focus on its direct-mail market segment.

u contributed by Valerie Switzer

Cable Act of 1992

On October 5, 1992, Congress passed the Cable Television Consumer Protection and Competition Act of 1992, commonly referred to as the Cable Act of 1992. The Cable Act of 1992 amended large sections of the Cable Communications Policy Act of 1984. The purpose of the 1992 act was to stimulate greater competition in the video marketplace and to impose new regulatory boundaries on the cable television industry with regard to its competitors and consumers.

In the years following passage of the 1984 Act, the cable television industry experienced intense growth. There was an increase in the number of cable systems and in the penetration rate, or percentage of television households with cable service, and the quantity and quality of cable programming services also increased. By 1992, nearly 60 percent of all television households were cable subscribers, and there were over 70 national cable networks. The cable industry was achieving its goal of becoming an important source of news, entertainment and information. The television broadcasting industry, cable's chief competitor, became increasingly alarmed over cable television's growth. It was feared that cable's escalating popularity would divert viewers and, more importantly, advertising dollars away from the broadcast services. Other potential competitors to cable wanted access to the industry's popular programming. Rising prices for cable television services generated criticism that cable was an unregulated monopoly. Together, cable's critics and its competitors amassed political support for congressional action. In part, the Cable Act of 1992 came about because of the cable industry's success.

Background

For several years prior to 1984, cable operators had been subjected to a variety of local regulations, many of which were arbitrary and unwarranted. In adopting the Cable Act of 1984, Congress determined that the local regulatory environment was thwarting cable's development. Among other things, the Cable Act of 1984 sought to reverse that trend and enhance the industry's development by prohibiting regulation where cable was subject to effective competition. With guidance from the legislative history that accompanied enactment of the new law, the Federal Communications Commission (FCC) established rules defining effective competition in terms of the presence of a minimal level of off-air broadcast service in a given cable community. As a practical matter, most local rate regulation of cable services disappeared by the end of 1987. With deregulation, cable operators were left free to offer, package and price their services to consumers. And, as noted above, cable television flourished in the post-1984 environment. Within a few years; however, cable's growth and the accompanying increases in cable rates began to produce political debate over the need to reregulate the industry. That process culminated in passage of the Cable Act of 1992.

Major Provisions of the Cable Act of 1992

The Cable Act of 1992 had two principal focuses. First, where cable television systems were not subject to effective competition, the Act provided an extensive regulatory environment to protect consumer interests. Second, the Act sought to promote greater competition in the distribution of multiple channels of video programming.

The Act directed the FCC to establish guidelines, consistent with a framework set forth in the statute, to ensure that basic cable service rates were reasonable, including charges for cable installations, equipment rentals and additional outlets. The statute defined basic cable service as that which included any carriage of local broadcast signals, encompassing those signals that must be carried on the system and any public, educational and government (PEG) access channels required by the local cable franchise. The local franchising authority was empowered to implement the FCC's guidelines. For non-basic cable services, other than per-channel and pay-per-view services, which are exempt from all rate regulation, the FCC would serve as the overseeing regulatory authority upon receipt of a complaint from a cable subscriber or franchise authority that a rate was unreasonable.

By redefining what constituted effective competition, nearly all cable systems immediately became subject to the new provisions on rate regulation. Under the 1984 law, the presence of a minimum number of local broadcast stations had constituted effective competition. The 1992 provision required the presence of a municipally owned system; the presence of another unaffiliated, multi-channel video distributor that served at least 50 percent of the cable community and had achieved a minimum subscriber penetration; or a finding that fewer than 30 percent of the households in the franchise area subscribed to the cable system.

The FCC adopted a regulatory scheme applicable to rates for both basic cable services and non-basic cable programming services. It defined benchmark rates for systems of comparable size that were providing comparable numbers and types of services. As a rule, operators were to reduce rates to the benchmark level or reduce their pre-Cable Act of 1992 rates by a specified percentage. Alternatively, operators could seek to justify higher rates under utility-like cost-of-service proceedings. Once permitted rate levels were achieved, subsequent rate increases would be limited to inflationary adjustments and the pass-through of certain actual cost increases, such as increases in the costs of programming, franchise fees and taxes. Implementation of the rate provisions brought about a general reduction in cable rates as of September 1, 1993. Revisions in the FCC rules brought about subsequent rate adjustments in mid-1994.

In addition to rate regulation, the Cable Act of 1992 contained a number of other provisions that were intended to benefit consumers.

Partly as a result of the vast differences in the quality of customer service provided by cable operators, the Act empowered local franchising authorities to establish customer service requirements and directed the FCC to adopt minimum standards for customer service, including telephone availability and response times for repairs. However, the FCC's standards could be relied upon by cable operators in fulfillment of their customer service requirements.

Another consumer issue addressed by the Cable Act of 1992 concerned the need for compatibility between consumer electronics equipment and cable television systems. Innovations in consumer electronics had made possible more sophisticated televisions and VCRs that were capable of providing an array of features and functions. However, at times customers were unable to fully utilize their equipment because of certain technical incompatibilities between it and their cable service. The Act directed the FCC to study the problem of compatibility between cable systems and consumer electronics with the goal of improving compatibility without impairing the ability of cable operators to use technologies necessary to prevent theft of cable service. The Act also instructed the FCC to adopt rules to specify the technical requirements for cable-ready consumer equipment and to require cable systems to inform customers when cable converters would prevent the customers from using the features and functions of their existing equipment.

To ensure the economic viability of local broadcast television, the Act required that cable systems carry the signals of local commercial and noncommercial broadcast television stations, including low-power stations in certain limited circumstances. Must-carry rules had first been imposed on the cable television industry by the FCC in the late 1960’s. Although they were amended from time to time, mandatory carriage rules existed until 1985, when they were declared unconstitutional. Absent must-carry rules, the system operator could refuse to carry a local television station and use the system’s limited channel capacity to carry cable programming that the community wanted or to carry a channel that would generate revenue for the cable system. The new provisions in the Cable Act of 1992 required carriage, at no charge to the local television station, of all local commercial broadcast stations and a minimum number of noncommercial stations. Up to one-third of a cable system’s total channel capacity had to made available for the carriage of local commercial broadcast stations. The Act also permitted commercial stations to elect not to be carried under the must-carry rules. Any station that elected against mandatory carriage could then prohibit its carriage on the cable system, absent a grant of retransmission consent by the station.

This provision reflected the sentiments of some broadcasters that they should be compensated for carriage of their signal by the cable operator. Upon implementation of the Cable Act of 1992, a number of broadcast stations opted in favor of retransmission consent. For the next three years, carriage of their signal would be dictated by the outcome of negotiations with the individual cable operator. As a practical matter, broadcaster/cable operator negotiations proved more complicated than some had anticipated, and in many instances only interim solutions were achieved.

Although the Cable Communications Policy Act of 1984 already required that a specified percentage of channel capacity be designated for lease by unaffiliated programmers, few programmers had taken advantage of those channels. To facilitate greater utilization and to promote competition in the delivery of diverse sources of programming, the Cable Act of 1992 directed the FCC to prescribe rules to govern the maximum permissible rates that could be charged to potential channel leasees.

Other provisions designed to foster greater competition directed the FCC to adopt rules governing cable program carriage agreements and related practices. Most significantly, the FCC was directed to adopt rules to prohibit discrimination by a satellite cable programmer which is owned in whole or in part by a cable operator in the prices, terms and conditions for sale of that service among cable operators or their competitors. Such vertically integrated cable services were also prohibited from entering into agreements to distribute their services exclusively to cable operators. Thus the 1992 law ensured that cable’s competitors, including wireless cable services and direct broadcast satellite (DBS) services, would have access to these cable programming services.

The late 1980’s was a period of time in which businesses in general experienced turnovers or acquired large amounts of debt. During this period, a number of cable systems changed hands. Observers of the cable industry became concerned that the trend was putting too much upward pressure on cable rates as new owners looked to recoup their investments. In past years, the broadcast industry had been subject to anti-trafficking rules that required owners to hold onto stations for a minimum period of time before they could be resold. A similar rule was now to be applied to the cable industry. The Cable Act of 1992 generally prevented cable operators from acquiring or building a system, then selling it within three years.

As a practical matter, few communities are served by multiple cable operators, even though nearly all franchises are non-exclusive. In an effort to encourage greater competition, the Cable Act of 1992 explicitly prohibited exclusive franchises and provided that franchising authorities may not unreasonably refuse to grant more than one franchise for an area.

The Cable Act of 1992 upheld the establishment of PEG channels and commercially leased channels, as established in the Cable Communications Policy Act of 1984, and maintained that these channels would be free from editorial control by the cable operator. Experience had demonstrated; however, that absent editorial oversight, the programming on some of the channels was sometimes distasteful or offensive. Because people were concerned about the content of programs on some of these channels, the Cable Act of 1992 permitted the operator to prohibit indecent programming on leased access channels. A court decision holding this provision constitutionally suspect is pending rehearing. The Act also generally prohibited obscene programming on both leased access and PEG channels. The Cable Act of 1984 already prohibited the transmission of obscene programming on other channels that are subject to the operator's editorial control.

To keep one provider from monopolizing or controlling what consumers in an area could watch and to help ensure that there were multiple independent channels of programming, the Cable Act of 1984 had prevented local broadcasters from owning a cable system in their service area. Likewise, under the 1992 Act, a cable operator is generally prevented from owning a multichannel multipoint distribution service (MMDS) or satellite master antenna television (SMATV) service within its cable service area.

u contributed by JDC Editorial Staff

Cable Communications Policy Act of 1984

An amendment to the Communications Act of 1934 to create a new section, Title VI, of that Act in which the United States Congress set forth, for the first time, a comprehensive national policy pertaining to cable television.

Although cable television began in the late 1940's, there were no laws in place to govern its operation and, unlike broadcast television, there was no national policy regarding the new industry. Cable began in rural America as a community antenna service that picked up broadcast signals and distributed them by coaxial cable to subscribers for a fee. As it developed, municipal involvement was generally limited to authorizing the use of local streets and rights of way and to adopting regulations to protect the safety of life and property.

As technology evolved, operators were able to offer more channels of service and gain greater acceptance in the marketplace, enabling cable TV's growth into more urbanized areas. The real catalyst in its development was the introduction of satellite distribution of television programming, which made possible simultaneous nationwide distribution of new programming in the mid-1970's.

Meanwhile, federal regulation of cable began in earnest in the 1960's with the adoption of rules to protect broadcasters from the importation of distant broadcast signals into a local market. A series of rules mandated the carriage of local broadcast signals and limited the operator's ability to provide other programming. Ultimately, many of the rules set forth by the Federal Communications Commission (FCC) were deemed unconstitutional by the courts because they unduly interfered with the First Amendment rights of cable operators. The FCC also announced a policy which allowed local authorities to select cable operators, issue franchises, and regulate the construction of cable systems and rates for certain cable services. There evolved in practice a crazy quilt of regulatory pressures and over-regulation by local governments which later was seen as an impediment to cable's continued growth.

Finally in 1984, Congress stepped in to establish a comprehensive national regulatory scheme designed to ensure that the industry would be allowed to develop in an environment free of unnecessary and economically burdensome government regulations. The new law, which became Title VI of the Communications Act of 1934, limited the cities' regulatory authority in certain respects but codified a regulatory framework in which the role of the local franchise, granted and administered by local authorities, was central.

At the same time, it constrained permissible regulation of rates, prohibited interference of any government in the selection of programming (except with respect to obscene programming) and established procedures for franchise renewals designed to foster investment in improved facilities, programming and services. The Act also imposed certain affirmative obligations on cable operators including implementation of equal employment opportunity policies; requirements to set aside channels for public, educational, or governmental use and channels for lease by persons unaffiliated with the cable operator; and other requirements designed to protect subscribers' right to privacy.

By 1992, however, much of the Congressional support for deregulating the cable industry had turned and new legislation was enacted. This legislation amended the 1984 law and is commonly referred to as the Cable Act of 1992. In particular, the revisions re-imposed obligations to carry local broadcast signals and established standards for regulating the rates for most cable equipment and programming services. Other provisions of the 1992 Act include provision for access to cable programming services by cable's competitors, cable equipment compatibility with consumer electronics equipment, consumer protection and customer service rules, and restrictions on ownership and sales of cable television systems. Additional amendments to the 1984 Act are under consideration as part of the current Congressional effort to overhaul the Communications Act of 1934.

u contributed by JDC Editorial Staff

Cable Drop System

The drop system connects individual homes to the coaxial cable that distributes cable television.

In cable television, the drop system is the final leg in the cable signal’s journey. It connects individual homes to the distribution system. The drop system begins at the feeder cable — the cable that the entire neighborhood taps into for cable television. If the feeder cable is aerial, or suspended on poles, the drop cable will typically be aerial. However, if the feeder cable is underground, the drop cable will be routed underground to the house.

The drop system is broken into two sections. One section runs from the feeder cable to the ground block. Here the drop cable is bonded to the house common electrode, which helps protect the house from electrical surges. The other section runs from the ground block to the television or converter box. The drop cable itself is a rather thin, semi-flexible coaxial cable. It is covered with braided copper or aluminum to help shield it from interfering signals. An outer jacket makes the cable durable. A splitter can be used to break up the cable’s signal and send it to multiple televisions in one home. However, because the signal traveling though the drop cable is like water traveling through a hose, the more it is split, the weaker the current becomes.

u contributed by Christopher LaMorte

Cable Trends

Imagine being one of 300 people locked in a room. The lock on the exit takes three keys to be opened and they are distributed evenly throughout the group. To get out the door, you must locate two people with the keys you don't have, convince them that they'll be better off partnering with you than someone else, then be the high bidder for their keys. Meanwhile, somebody sneaks in every few minutes, changes the locks and throws new keys into the air. The trends in the cable television industry are geared toward: finding a new key, locating two partners and being the first ones to open the door. Oh yes, the lights are off and the air is running out, too.

Perhaps the most important thing to know about cable industry trends is what's on the other side of the door. What's there is what was promised to American consumers years ago — a society in which people, places and things are at our fingertips. Consumers are often like kids who stretch their arms out to grab pieces of candy, only to find that the morsels are out of reach. Many entrepreneurs and large businesses are coming up with ways to give kids longer arms, while some are making more appealing candy. The rest of us are the kids who are still reaching.

But the entrepreneurs are like kids too. The candy may be different, but their arms are just like ours — a little too short to grab it, just long enough to touch it.

The trends depend on which of the three cable businesses a person is in: manufacturing, programming, or distributing.

Manufacturers

Cable equipment manufacturers chase the future, then circle back to the present, repeating the process in a tighter and tighter spiral as the future comes closer. They have to produce inventory that meets the needs and requirements of yesterday's cable systems and design equipment that will deliver tomorrow's promises. The problem is, the cable system of the future might involve a telephone network or it could involve a computer network. The network transmission medium might be fiber optics or a hybrid of fiber and coaxial cable. But if manufacturers keep compressing the signal and making technological advancements at their current rate, the transmission medium could literally dissolve into thin air and everything would be wireless.

Cable equipment manufacturers have always competed with each other for business, and now they're competing with companies that make telephone equipment and computer hardware and software as well. If a digital converter or set-top box looks like a personal computer (keyboard and mouse), feels like a personal computer (lightweight and portable), and acts like a personal computer (displays all programs that mention North Dakota, for example), is it a personal computer (PC)? You don't see many PCs with names like Scientific-Atlanta, Jerrold or General Instrument on them. The trend is for these traditional cable equipment manufacturers to pair up with established computer companies like Microsoft for software and IBM for hardware.

But the central element in the road to the future is a speed bump called standards. Oddly enough, standards are only a speed bump if they don't exist, and in some cases they do not. Standards are those things that allow manufacturers to start building inventories of equipment with the confidence of knowing someone will buy them. For example, will Digicypher, manufactured exclusively by General Instrument, be the standard for digital images, or will the standard be the one from the Motion Picture Experts Group, MPEG 2?

And what about consumers? Many have already been through the VHS vs. Beta VCR wars of the 1970's and 1980's; the Apple vs. IBM wars of the 1980's and 1990's; and the 30-year long Music Format Wars that pitted 8-track against cassettes, cassettes against vinyl, vinyl and cassettes against compact discs, and all but 8-track against vinyl. All of these wars produced, or are in the process of producing, de facto standards; whoever sells the most units dictates the standard and can license the technology to everyone else for lots of money.

Every manufacturer hopes that the last television analog converter ever made doesn't come off its assembly line and that the first digital unit built to a doomed standard doesn't either. The insurance policies against failure are interim agreements, spur-of-the-moment alliances, and strategic partnerships that harken back to the days when chiefs and clan leaders offered to marry off their children to gain favorable treatment from threatening bands and kingdoms.

Cable equipment manufacturers will eventually put digital technology into the hands of the distributors and programmers so they can utilize it to bring the products and services to viewers.

Programmers

In the modern world of television, the programmer's job is to produce or provide programs that appeal to various audience groups. The advertiser supports that programming, and in turn is given access to the audience to deliver its message. Audiences are designated by their demographics, such as age, income, and status: for example, 22 to 34-year-olds with an income between $27,000 and $42,000 who are married and have 1.7 children. This method of delineating the audience serves the interests of the programmer, the audience and the advertiser. It allows a programmer to design programs to serve (entertain, inform, educate) various demographic groups. Each segment of the audience has access to programs that interest the group. And advertisers can target their commercials to the viewers that will probably be interested in their message or product.

The trend for programmers is to try to figure out what people will watch when they don't *have* to watch what's on. Programming will change dramatically with interactive television (IT) and raise a lot of questions. With IT, the viewer can watch the football game from the end-zone camera or isolate on the left tackle. What does the announcer say if he doesn't know what the viewer is watching? If a person can play *Jeopardy* at home and win money, how do the producers know the winner didn't look up the answers (or questions) on her personal computer?

But a question (or answer) that consumes a great deal of time and energy in the television business is, When IT comes along, who's going to pay to advertise when the viewer doesn't have to watch the commercial?

And beyond traditional television, how will advertising be structured for a situation in which the viewer can choose to circumvent the commercial or choose to order from the commercial? Programmers and advertisers believe that viewers will want more than the traditional advertisement, because they will be able to purchase directly from the screen. Each commercial will become a point-of-purchase advertisement, not a commercial for a purchase that may happen days or weeks later. It has long been said of advertising that it doesn't sell the steak, it sells the sizzle. It remains to be seen what changes will occur in television advertising when it actually does sell the steak.

When viewers want product information or are in a buying mode, they will have access to several shopping channels. They can click and order, conduct transactions, purchase off the screen — whether on a whim or after a short amount of time spent comparing 15 brands by accessing data on each one via their television terminal.

Commercials within programming could be structured so viewers could order immediate printouts of product specifications or a list of local dealers. They could even order it for next day delivery.

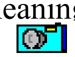
Another change is that movies will be available on demand, not by driving to the store and renting them, and not by watching what's on when the programmer decides it will be on. And with interactive video, the pause and fast forward functions will give the viewer total control, including the option of watching the movie later. Time and space will become irrelevant, as will the humiliating act of trying to program the VCR.

Viewers will still be attracted to the type of programming they enjoy; but in a 500-channel environment, what constitutes a respectable audience share?

When cable equipment manufacturers provide the digital technology to expand the information and 1102 choices, programmers will use it to provide an explosive array of programs that invite the viewer to not just watch, but also participate.

Distributors

These are the cable systems that have brought us as many types of programming as there are flavors of coffee. Like manufacturers and programmers, distributors have to figure out the difference between what people want and what they'll pay for.

The trend here is to converge, a term meaning to mash every electronic service possible into a stream of digital ones and zeros  and send it down a conductor to your house and your office, then remove the conductor and send it to your car.

In the past, consumers could put services and products into neat boxes --telephone, gas, cable, electricity, library, groceries -- and each was distinct, each identifiable by name and provider. The telephone company did telephone things, the cable company did cable things. There is no name for the companies of the future, no name for the services they will provide, and only nonsensical names for the network that will carry the bits and bytes: infobahn, I-way, information superhighway, all trying to associate the known past with an unknown future by using words and images to which people can relate. But the distributors aren't building the networks like highway systems, they're building them like a central nervous system. Their neural networks have nodes and signal origination points all over the place. Some signals will go to only one group of people; others will go to all groups, not based on subscribership, but on demographics and needs.

The current distributors of information-based products and services are scrambling to be the provider of the future. 78 can deliver telephone. Telephone can deliver television. Utility companies can connect distribution points with fiber. Satellites can spray invisible signals everywhere. Computers are interconnected via phone lines, and they aren't just displaying text anymore, they're bringing in an improved quality of video and graphics.

The trend for distributors is to fight it out in the trenches among themselves, using technology, regulations, public opinion, products, services and the shortcomings of the other contenders as weapons to advance their own cause. Sure there's cooperation, but with an edge.

If it's confusing for the cable manufacturers, programmers, and distributors to be locked in a dark room with each other, imagine yourself in the same situation with representatives from a telephone provider, cable operator, computer builder, software programmer, wireless salesperson — with no key, clue or idea. What do you do? What do you want? What will you pay for?

If the technology converges, if the programming evolves, if the network connects, then each of the communication devices in the home, including the home itself, will become extremely powerful tools to entertain, inform, influence, educate, liberate, nurture… depending on how consumers, and society, choose to use them.

The cable trends may look confusing, but trends are only tendencies. What matters is that people take part in inventing a technological future that enriches their lives through access to a full spectrum of art, information, education, and interpersonal communications, creating a new level of empowerment.

u contributed by Paul Stranahan

Cable TV Advanced Technology

The cable television (CATV) industry has come a long way since it began using community antennas to receive broadcast signals and distribute them to homes on twin-lead wire. For the first 40 years, the vast majority of technological advancements in the CATV industry were driven by engineering requirements to improve signal quality, expand systems to cover larger geographical areas and deliver more channels. Today the driving force behind technological change in the CATV industry is competition. It focuses on making CATV the primary carrier of digital sound and video plus voice and data communications to homes and offices. The advanced technology will let the CATV industry deliver more of its staple — entertainment — and expand into services and products that will enhance education, improve access to information and deliver interpersonal communications.

The industry that connects homes and businesses with a fiber-optic, high-bandwidth, fully switched digitized network can deliver video, voice, data and interactive television. The major areas of technological advancement are: fiber optics, bandwidth, digital transmission and digital compression. While these are the individual areas of focus, the capability to build the network of the future requires that all four be in place.

Fiber Optics
When the CATV industry's main business was entertainment, it did not require fully redundant system design and 100 percent reliable service. The lives and money of the customers were not at stake if they didn't receive an episode of a television program or a movie. But now that CATV is entering the communications business, to successfully compete it must provide 100 percent reliability, and to accomplish this, redundant systems are necessary. This has changed the architecture of cable systems from the traditional tree and branch to the node design used for fiber-optic networks.

Nodes provide service to small groups of customers and were originally placed to meet engineering requirements that included redundancy to ensure that telephone signals would get through. Now the layout of nodes can ensure better reliability and also allow advertisers to market to discrete groups of people. With fiber-optic cable and smaller nodes, television advertising can be done by ZIP code, just as direct-mail print advertising is now done, or by even smaller groupings of 500 homes served by a single node. In addition, video on demand (VOD) will probably use this same small-node architecture.

In 1993, the CATV industry deployed 221% more fiber (428,700 miles) than it did in 1992 (193,800 miles). Fiber-optic cable that is not presently used, called dark fiber, is also being installed to meet future needs. Changes in the channel capacity for each fiber have increased capacity from 18 to 80 video channels per fiber.

For the traditional CATV services, this greater capacity means expanded choices for viewers and increased growth potential. Picture quality will also improve because there will no longer be long cascades of amplifiers to maintain signal strength.

As the industry moves into new areas of services and products, fiber has other advantages. It enables cable operators to at least prepare to battle for access to customers who need data and phone services. One new service is personal communication service (PCS). It enables customers to place phone calls from within microcells equipped with antennas. The signal is sent via fiber to interface with the public switched telephone network (PSTN), then routed to another cell antenna, where it is sent to the receiving device. The fiber network for these services could be owned by CATV companies.

Fiber-optic cable is also one of the key elements in developing interoperability between a cable customer and the cable system. Someday, the broadband capability of fiber will be available in both directions for duplex communications, so customers may have full interactivity with services. By using their own fiber link, customers may be able to order movies, conduct shopping and banking transactions, and access a wide variety of information and education services.

Fiber also allows the interconnection of local area networks (LANs), wide area networks (WANs) and metropolitan area networks (MANs). And the interconnection includes the cable area network (CAN) for the distribution of cable services via fiber optics. Any new cable architecture, or for that matter, any architecture for telephone service, must include interpretability between various services and multiple networks to be able to deliver services seamlessly to customers.

Speed is certainly a factor in all telecommunications. The ability to smoothly transmit data, whether digital video or computer data streams, depends in part on how fast the data can be sent. Theoretically, digital transmission of full-motion, color video requires a data transmission rate of 10 to 100 megabits per second (Mbps). The data transmission rate of twisted-pair phone lines is much less than that, closer to 1.5 Mbps. But even once the network is a hybrid of fiber and coaxial cables, video switches that can transmit compressed digital video signals must be in place.

In the past, CATV's primary market was residential neighborhoods, because it sold entertainment that was used in the home. Now, to compete, CATV must penetrate the areas it previously passed by: the places where people work. To do that and provide the kinds of services businesses need, the use of fiber-optic cable must be expanded.

Bandwidth

In the real estate business it is said there are three elements of success: location, location, location. In telecommunications there are also three elements of success: bandwidth, bandwidth, bandwidth. Each radio frequency or communication channel on a CATV system consumes a portion of the available bandwidth. Over the years, cable operators have been increasing the bandwidth of their systems so they could carry additional television channels. Cable systems with a bandwidth of 450 MHz are common and deliver over 50 channels, but to move into the data and telephone businesses, VOD and interactive video (IV), some experts feel that a minimum bandwidth of 550 MHz is needed. Some cable systems are building or upgrading to 750 MHz, but the number of such systems is small.

While CATV is moving toward adequate downstream bandwidth to get signals to the customer, one of the remaining problems is the upstream bandwidth to carry signals from the customer to the cable system headend or interconnect with other networks for telephone, data, and interactive services. The available bandwidth for these upstream signals is small, ranging from 5 MHz to 42 MHz, and it is sensitive to the ingress of other frequencies.

Several technologies help to overcome the problem of limited bandwidth. One is to make more efficient use of the existing bandwidth by sending signals in the guard bands that separate each channel from those next to it. A second method of making better use of the existing bandwidth is to use technology borrowed from wireless protocols: frequency hopping and time-slot management. In these, the system would hunt for the cleanest available cable channel within certain parameters and use it.

Another way to increase the efficient use of the upstream bandwidth is to compress the signals; but first, the signals must be digital.

Digital Transmission

Digital television cameras and recorders have been in use for several years, digital audio is practically ancient in today's fast moving technology, fiber-optic cable and coaxial cable have been transmitting digital signals for a long time — so why is digital such an issue?

First of all, if an encoded digital signal arrives at a television, but there's no device to decode it, is there a picture? No. Today, every television set in the United States is analog; each TV takes a continuously changing radio frequency wave and puts out the video and audio as an analog message. Even if tomorrow the CATV industry were able to get a digital signal to the house of every subscriber, there is nothing attached to the television set to convert the signal into something it can understand. One of the fundamental pieces of equipment for digital video is still missing: a digital set-top box or converter.

This box will use digital technology for more than authorization to receive a pay-per-view program; it'll also enable on-screen displays, messaging, memory for frequently watched channels, parental block out, perhaps a printer and keyboard, and enough processing power and memory to qualify as a personal computer.

Someday, digital networks will provide the cable customer with an electronic programming guide (EPG), interactive video games and transactional services, such as banking and buying, digital audio, movies on demand and even control of programming elements such as camera angles.

For the cable operator, digital transmission opens the door to digital advertising insertion within 30 minutes of receiving the commercial, as opposed to the hours or even days it now takes to prepare a commercial. Advertisements could be stored on a special computer that functions as a video server, inserting commercials when called for.

Although television and film production techniques will eventually change to accommodate digital transmission, for the present, digital reproduction can change the way a program looks, alter what the director intended, and what the cinematographer shot. Do CATV companies have the right to do that? Did colorization of black and white movies open the door for cable companies to change the visual content of a program?

One problem that has been overcome is that digital takes a big bite out of the available bandwidth – in fact consuming more than an analog transmission. A standard television channel is 6 MHz wide, too narrow to accommodate a digital signal that carries the information needed to create a full-motion video picture. Since the Federal Communications Commission (FCC) has required digital to fit into a standard television channel, one of the keys to digital transmission of moving pictures, and the solution to the problem, is digital compression.

Digital Compression
Compressing digitized pictures is a process of removing extraneous or redundant information. It strips away the visual information that the human eye does not need in order to understand what it sees. Fooling the eye is nothing new. A television picture shows no motion whatsoever, it merely fools the eye into thinking it sees motion. Similarly, decompressing the compressed image reinserts visual information to fool the eye into thinking it is seeing a complete picture. By this process, the picture appears to the viewer to be like the original, but in fact it is not the same as the original.

Current digital compression is now capable of compressing full-motion video by a ratio of 4:1. Since the compression ratio depends upon how much the picture, either the background or foreground, changes from frame to frame, better compression ratios of 8:1 can be generated, and 20:1 is in the foreseeable future.

Until mid-1995, what was lacking was a standard for digital compression that everyone could use and adhere to. The Motion Picture Experts Group has created one standard, called MPEG 1, and has recently completed an advanced standard called MPEG 2. Meanwhile, General Instrument Corporation is building set-top boxes using a different standard, called Digicypher, a technology that the company owns. With three standards, the race is on to see which will become dominant.

The United States has settled on digital high-definition television (HDTV) as the technology of the future, the next generation of televisions. The picture is 25 percent wider than the current television picture and has twice the scan lines (the horizontal paths traced by the electron gun as it displays each frame or picture). NBC television has announced plans to begin broadcasting digital HDTV signals in 1997.

Given the data processing power and capacity required by an HDTV set and the digital information it processes, in some ways it differs little from a personal computer. With the transmission of compressed digital signals on the not too distant horizon, and new HDTV standards being tested, what people are seeing is the beginning of convergence.

Convergence and Interoperability
Since many of the communication technologies are experimenting with the same equipment, architectures and services, they are said to be converging; all are pursuing the same goal from differing directions. The goal is to build a communication network that culminates in a single wire/cable/fiber from every home in America to every home and business in America, or perhaps even the world. This access route that begins at the home or office would carry telephone, television and data. Switching would enable every television set to be connected to every other television set, just as all telephones are accessible from all others.

If the CATV industry develops one system, the telephone industry another and computer companies another, the networks may not be able to operate together or interconnect.

Interoperability, the capability of each cable system, each telephone service area, even each utility service area to send and receive information between all others, is essential. That's why cross-industry standards are critical. That's also why communication among the major players and each segment of the industries is crucial now. Without mutually compatible standards, equipment from one manufacturer will not interface with the equipment from other manufacturers.

The American National Standards Institute (ANSI) is coordinating standards for the various types of communications. The ANSI Information Infrastructure Standards Panel (IISP) is bringing standards together so the various systems will work together in the United States as well as globally.

The Vision

So, with all that's happening, what can be said about the future? It will surely be different — more information available, more interactivity with that information and more competition to be sure.

But what's in it for the average person? Perhaps cellular television. Using small cells, like those used for cellular telephone, broadcasters could provide HDTV programming with no interference during prime time and have substantial spectrum left over for wireless communications during business hours.

Perhaps it will be homes that manage themselves. Internal software or microprocessors would control the flow of data, power, water and gas into a house, then control each appliance so that it meets the owner's needs. This technology could be used to control personal computers, televisions, utility meters and thermostats, and even the toaster.

Perhaps a user will tune in on the tube to read a newspaper, converse with a friend who lives in Pakistan, or examine the Dead Sea Scrolls or KGB papers from the Cold War era. These are all possible now, but later they could happen on the television terminal instead of the computer terminal.

What's Needed to Get There?

Experts do not necessarily agree. However, to access the on-ramp to the information superhighway, the CATV industry needs a high-speed RF data modem that can deliver a video signal just as telephone modems deliver signals to computers. A cablephone is needed so customers can call up friends and talk face-to-face as easily as they talk voice-to-voice now. A true operational support system (OSS) is required for billing, status monitoring, dispatch, measuring traffic and identifying bottlenecks in new interactive networks. The OSS becomes the key administrative structure and server of all those wonderful services that are only remote possibilities without it.

When cable begins delivering phone signals, interactive services, high-speed data traffic and near video on demand (NVOD), a synchronous optical network (SONET) could be used to transport high-speed optical signals, improve reliability by providing for route redundancy, enable services to be added or dropped easily and provide better network management. SONET offers higher bandwidths, multivendor compatibility and greater bandwidth management.

Another advanced technology is asynchronous transfer mode (ATM), which makes more efficient use of networks for data, phone and video. In almost any transmission there are blank spots, or short periods of time in which no data, voice, or picture is actually being sent. ATM uses the blank spots in a transmission to send other communications. By filling each circuit, ATM increases the efficiency of the available bandwidth, instead of committing an entire circuit to one communication, even when the circuit is not being actively used.

ATM combines the best features of packet switching and circuit switching. Packet switching means that each user's data is divided into small segments, placed in packets that are addressed to the receiver, then sent along with other packets. This makes sure the circuit is always full. In packet switching, packets containing time-dependent information, such as video pictures, receive priority over data packets to ensure that the data making up a television picture does not pause and create a jerky picture. Circuit switching means that when a call is placed, a fixed capacity is allocated and stays allocated whether there is data being sent or not — for example, when a telephone caller is put on hold. Another big plus for ATM is that it can switch streams of multimedia traffic at mind-boggling speeds.

Advanced technology is not futuristic technology; most of it is out of the laboratory and is being trial-tested in cities today. As these and other advancements get to the marketplace, the networks will become real; as future advancements are made, new access and services for customers will take full advantage of the technology.

u contributed by Paul Stranahan

Cable Telecommunications: History And Development

The history of cable television (CATV), now referred to as cable telecommunications, begins as a tale of three cities: Lansford and Mahanoy, Pennsylvania, and Astoria, Oregon. In these three towns, cable pioneers developed, almost simultaneously, a technology which has impacted international business, culture, education and information delivery systems. It is an industry which has grown geometrically, from approximately 250,000 households in 1955 to more than 59 million in 1993. But its pioneers had only two initial goals in mind: to improve television reception in mountainous terrain, and to sell television sets.

Television in Perspective

By 1948, television was rapidly evolving into a universal entertainment medium. Sales to consumers grew from 6,000 in 1946 to almost one million in 1948. Limited television service was available to major metropolitan residents, but rural residents and anyone more than 50 miles from the city were mostly unable to receive the distant signals. During this period hotels and apartment houses were receiving radio and television signals using master antenna systems, coaxial cable systems which operated for the single structure. Also in 1948, the Federal Communications Commission (FCC) froze licensing of new broadcast stations, which made the popular early notion of local television stations in every city impossible. Meanwhile, appliance manufacturers had distributed their wares across the nation – even in towns with little or no reception.

Cable Pioneers

John Walson, Mahanoy City, Pennsylvania

John Walson, a maintenance worker for the Pennsylvania Power and Light Company (PP&L) is one of several cable pioneers. Beyond his work for PP&L, Walson also had an interest in an appliance store in Mahanoy City which offered television sets for sale in early 1948. It was difficult for Walson to sell the TV sets, as reception varied from Walson's store to his customers' homes within the town's mountainous terrain.

Walson constructed an antenna at the top of a nearby mountain and strung cable down the mountain to his store. This enabled him to obtain pictures from three channels in Philadelphia. Walson later obtained permission from Pennsylvania Power and Light to attach his wires to the company's poles for a small rental fee ($1.50 per pole per year).

Soon, friends and neighbors were interested in receiving the TV signals as well, and Walson extended his system to anyone who purchased a television set from him. In 1949, Walson rewired his system with sheathed coaxial cable, and charged his customers $100 for the installation and $2.00 per month for the maintenance of the service. He called his cable system Service Electric Company.

Walson first requested franchising privileges from Mahanoy City officials in 1950.

During Walson's initial demonstrations of the reception service, William McLaughlin, Mahanoy City's Chief of Police, decided to launch his own cable service across town, which he named The City TV Corporation. Walson bought out McLaughlin's system later, and grew his business to other communities. He eventually served more than 85,000 customers.

Ed Parsons, Astoria, Oregon

Ed Parsons, a radio station owner and electronics tinkerer, promised his wife a television set as soon as local TV signals became available. In the summer of 1948, KRSC-TV in Seattle, Washington, 150 air miles from Astoria, began broadcasting. Parsons began a quest for a usable TV signal and found one atop the nearby John Jacob Astor Hotel. Walson was granted permission to mount an antenna on the roof of the hotel. Communicating with his wife via walkie-talkie, Parsons adjusted the direction of the antenna from which he had connected lines leading to his TV set. Using the antenna and homemade amplification equipment, Parsons received the signal from KRSC-TV on one channel and sent it out on another. Their home quickly became a popular spot for townspeople to visit.

Tired of the crowds, Parsons connected a TV in the lobby of the hotel and one across the street in Poole's music store. Eventually, Parsons' crews were installing 20 sets a month for $100 each.

Parsons requested, and was granted retransmission consent (the right to retransmit TV signals) from KRSC-TV. The station manager gave his permission under several conditions, one of which included the revocation of this permission at any time.

Robert Tarlton, Lansford, Pennsylvania

In the coal-mining community of Lansford, radio dealer Robert J. Tarlton was faced with the same reception problems being experienced in other mountain communities. Towns like Summit Hill, just one mile up the mountain, could enjoy television without interference. After reading about master antenna systems for apartment buildings, Tarlton approached three other radio/TV dealers in Panther Valley to complete some experiments. Under the title Panther Valley Television, a group of five men, Tarlton, George Bright, Rudolph Dobosky, William McDonald and State Assemblyman William Scott, constructed an antenna in Summit Hill. They too rented poles from the telephone companies to extend their cable into the town of Lansford. The group used equipment from Philadelphia-based Jerrold Electronics.

Other Pioneers

Milton Jerrold Shapp launched Jerrold Electronics in 1948. His company installed master antenna systems in apartment buildings. Shapp visited Robert Tarlton's Lansford system and then dedicated his engineers to design equipment that would distribute cable television signals more effectively. The Lansford system received a great deal of publicity, and in time, Jerrold Electronics became the leading CATV hardware manufacturer.

Shapp was also a leading negotiator with telephone companies to receive fair pole attachment lease rates. He argued that over time, fair rents would actually save telephone companies money, because rural residents had begun to assemble their own antenna towers to receive TV signals. These structures were unstable and toppled onto phone lines during inclement weather.

Shapp sold his equipment under strict quality-control guidelines. For a percentage of the installation fee and a monthly fee per subscriber, Jerrold Electronics assisted with system maintenance, replaced faulty hardware and provided technical training. Eventually, Shapp and an investment group purchased six cable franchises. Milton J. Shapp later served as the Governor of the state of Pennsylvania.

Early Friction

Social Impact

In Lansford, residents rejoiced at being able to watch the comedy of Milton Berle from the comfort of their own homes. But tavern owners in nearby Summit Hill, which formerly boasted the only clear local TV signals, were dismayed at their sudden loss of customers. This phenomenon has become a trend throughout the last 40 years from the founding of cable to the invention and proliferation of the video cassette recorder (VCR), pay-per-view services, and the creation of individual, multimedia home theaters.

Copyright Issues

But beyond social trends, program and music originators felt their rights were violated in view of the rebroadcast of their entertainment materials. When the American Society of Composers, Authors and Publishers (ASCAP) learned that Ed Parsons had received retransmission consent from Seattle's KRSC-TV, they demanded royalty payments for music retransmitted on his system. Parsons, a radio station owner, responded by banning all ASCAP music from his Astoria station. Soon ASCAP withdrew its demands, and Parsons resumed playing ASCAP-originated compositions.

IRS Tax Inquiry

As demand grew for cable in the 1950's, the Internal Revenue Service noticed the industry growth and demanded an eight percent excise tax on cable television. The IRS focused its efforts on Lansford and Honesdale, Pennsylvania, an area where cable was flourishing. Cable operators from Pennsylvania towns assembled in Pottsville to discuss the IRS action, and decided to organize a group to represent the industry. The National Community Television Council began in September of 1951 as the precursor to the National Cable Television Association (NCTA), the Washington, D.C.-based assembly that currently represents industry interests.

Importation of Distant Signals

In 1952, the FCC began to license new broadcast television stations again. Although many new stations were launched, outlying communities still lacked reception, and cable continued to grow. Cable proved to be an advantage to broadcasters, who sold their advertising time for higher revenues based on the increased audiences available through cable reception. But as cable grew in the late 1950's, cable operators began to import distant signals via microwave relay systems for their customers. Cable then became viewed as a source of competition to broadcasters, as it was able to improve reception and offer programming choice. Broadcasters exerted pressure on the FCC and in 1962, the FCC issued an order placing restrictions on the importation of distant television signals. This action stalled cable growth and profits just as operators were beginning to build cable systems in large, urban markets.

In 1966, the FCC further responded to broadcasters' inquiries into the competitive threat of cable television by asserting jurisdiction over the entire industry. Cable companies were then required to carry all local broadcast programming.

A 1970 ruling prohibited pay cable channels from offering movies less than ten years old, or any film that had been aired over free television within three years.

Pay Television Sparks Cable Growth

The extensive growth of cable television may be attributed to two factors: consumer interest in commercial-free programming services such as uninterrupted theatrical films, and the subsequent technological innovations (namely satellite-delivered signals) that were developed with the product.

The first pay TV experiments occurred as early as 1930, but the format was not widely tested until the late 1950's. Phonevision, a joint venture between RKO General and the Zenith Radio Corporation, represents one of the earlier pay TV efforts. The experiment scrambled signals from a UHF station in Hartford, Connecticut. Viewers ordered Phonevision over the telephone, and the station activated an unscrambling device located in the viewer's television.

In 1958, Jerrold Electronics launched a 10-month pay television experiment in Bartelsville, Oklahoma, using cable transmission. Other trials included actual coin-operated set-top boxes.

STV

Subscription Television, known as STV, was launched in early 1964 in San Francisco and Los Angeles, California. Matthew Fox, a film producer and distributor, conceived STV as a means to become wealthy by convincing Hollywood studios to release their features to television more quickly. Fox also believed the business would grow through offering exclusive programming like professional sports. Baseball's Dodgers and Giants moved to California, in part, to distribute their match-ups via STV, instead of over-the-air broadcasts.

Sylvester L. "Pat" Weaver, NBC's former President, joined STV to lend credibility to the project for its shareholders. As STV heavily marketed its services, movie theater owners in northern and southern California who feared losing income organized their opposition to the business of pay television. The Citizens Committee for Free TV, a group backed by theater owners, managed to pass Proposition 15, which outlawed most forms of pay television.

Home Box Office

In 1971, Charles Dolan, the Founder and President of Sterling Manhattan Cable, thought that a pay television service comprised of live sporting events and uninterrupted older films might attract additional subscribers. He suggested that the service might be relayed via microwave to other cable systems in the northeast who would sell the service to their customers. Home Box Office (HBO) launched in November 1972 with the coverage of a live NHL Hockey match.

Although HBO soon boasted 1,400 customers, the cost of microwave relays prevented real growth of the fledging pay network. Gerald Levin, Dolan's successor, decided that HBO should try to exploit the relay potential of SATCOM I, a domestic communications satellite RCA had scheduled to launch in 1975. The leasing of a transponder on the satellite would enable HBO's signal to be transmitted anywhere in the U.S. To receive HBO, cable operators needed a receiving dish, which was a costly investment. Still, by early 1977, 262 cable systems received HBO's service.

HBO and cable operators lobbied Congress successfully in 1977, and the restrictions on pay TV content were deemed anti-competitive. Three years after satellite service began, HBO had two million customers and offered a line-up of sports and theatrical films. The cost of receiver dishes dropped over time, and the receivers had the ability to pick up signals from more than just HBO. The use of satellite technology revolutionized the potential of the cable television industry to provide alternative programming choices to cable customers in addition to improved reception.

QUBE

In 1977, Warner Cable began experimenting with QUBE, an interactive pay television service. Customers who purchased QUBE could push buttons on hand-held consoles attached to their TV's to order special services like stock market reports, movies on a pay-per-view basis and other services. The two-way communication service was rolled out in Pittsburgh, Dallas and the St. Louis suburbs. Warner acquired franchising rights to several communities based on their intention to roll out QUBE services. The project ended as Warner systems sold to other cable operating companies, and as franchise agreements became lax.

Cable Network Growth

In 1976, Ted Turner used SATCOM I to relay his UHF channel, WTCG (now called WTBS) from Atlanta, Georgia. His mix of live sports programming and movies constituted the first superstation, a broadcast station whose signals are transmitted to cable systems out of its geographic region. Subsequent services like Showtime, The Movie Channel, Turner's Cable News Network (CNN), and ESPN (the Entertainment and Sports Network), also began to flourish using satellite delivery. In 1979, the cable industry funded C-SPAN, the Cable-Satellite Public Affairs Network, which offers gavel-to-gavel coverage of the House of Representatives.

The 1980's

For the cable industry, the 1980's was marked by an explosion in the growth of cable networks (like the launch of MTV: Music Television in 1983), and the outright battles for franchising rights to major metropolitan areas.

With satellite technology firmly entrenched, cable television offered unparalleled programming choice versus broadcast television. The delivery of entertainment had become big business, and the rights to provide the service to municipalities were sought aggressively.

The Cable Communications Policy Act of 1984 effectively deregulated the industry. The Act freed operators from rate regulation and virtually guaranteed renewal of their license agreements with their reasonable attention to the various facets of franchise agreements. The Act again prohibited telephone companies from entering into the video delivery service business in their respective service areas.

The new liberation facilitated by the Act allowed cable operators access to financing which had previously been unavailable based on the unattractive limitations to industry growth. From 1984 to 1989, the cable industry spent more than $15 billion on wiring the U.S. By the end of the decade, nearly 53 million households subscribed to cable. During this same period, the number of cable programming networks increased from 28 to 74.

During this extreme growth period, critics allege that some cable operators raised cable rates arbitrarily and provided poor customer service. Many of the "blue sky" promises established during franchise negotiations were slow to be fulfilled.

The 1990's

The 1990's began a new era of cable television characterized by viable competition, reregulation, cable network growth, and the beginning of the convergence of the computer, cable, and telephone industries.

In 1992, Congress passed The Cable Television Consumer Protection and Competition Act (commonly called the Cable Act of 1992). It dictated rates customers paid for cable services through a series of complex formulas based on the number of channels offered, among other factors. Broadcasters also received certain rights for their carriage on local cable systems under the clauses known as Must Carry or Retransmission Consent. For each cable headend which disseminated broadcast signals to a cabled community, broadcasters elected either mandatory carriage on systems (must-carry) or opted for receiving retransmission consent, because they felt that their programming, like cable network programming, was a valuable commodity which deserved to be paid for. (This followed the model that cable networks earned income two ways: through advertising sales and through fees per subscriber paid by cable operators). In choosing retransmission consent, cable operators had to obtain the permission to rebroadcast the program signals of local broadcast stations. In exchange for this permission, broadcasters could demand some form of compensation.

Three national broadcasters decided to launch their own cable networks and guarantee these new networks carriage on cable systems via retransmission consent negotiations. (Fox launched fX, ABC began ESPN2, and NBC initiated America's Talking.)

The Cable Act of 1992 also required that all purveyors of video delivery services would have equal access to programming content. The Act's Program Access rules enabled cable competitors like direct-to-home satellite companies to offer programming services that were formerly exclusive to cable.

On a city and statewide basis, telephone companies were aggressive in their efforts to win the right to provide video services. By mid-1994, two regional Bell operating companies, Bell Atlantic and Ameritech, had overturned previous rulings barring their entry into video. Cable operators were equally anxious to enter the telephone business.

Industry Convergence

National and local policies, along with new technical developments like the proliferation of fiber optics, have paved the way for multimedia services and service providers. And at the same time that phone companies and cable operators have been battling to enter the other's business, many firms have created partnerships to launch future combined cable/telephony operations and Personal Communications Services. (These include Time Warner and U S WEST, and Jones Intercable and Bell Canada International). Computer hardware and software manufacturers have also been active in the race for new services by making on-line services attractive and accessible, and providing vital network links for the rapid transfer of data.

National telecommunications policy may dictate when, where and how new technologies are provided to potential customers.

u contributed by Robin Rothman

Cable Television Industry

The cable television industry began in 1948 to provide television signals to towns that were too distant from television stations to get a picture or that were located in areas where the signal was obstructed by mountains. The technology of community antenna television (CATV) was simple by today's standards, and in many of the small mom and pop companies, the owners climbed poles, knocked on doors to get new customers and licked the billing envelopes. Today, the cable television industry is a multibillion dollar international business with ties to dozens of other industries.

As the new CATV industry tried to grow outside of small rural areas, it encountered a complacent public attitude. When asked to pay for television, most people replied, Television is free, why should I pay for it? In 1975, when Home Box Office (HBO) began offering movies, cable television finally had something new and exciting to offer, something that people would pay for. HBO's emergence was the single event that allowed CATV to become a serious contender for the television viewer. The success of HBO, followed closely by the launch of Showtime and Cinemax, brought about a rapid expansion in cable channels and networks and helped create a complex communications industry.

Industry Organization
Today, to most people, the CATV industry consists of the company that they pay each month for service. But the industry is actually made up of three vital elements that serve each other. The three major divisions of the cable industry are programmers, distributors (owners and operators of local cable systems) and manufacturers (including research and development).

Essentially, programmers are those companies that produce and/or sell programs to the distributors. For many years, the only two markets for programmers were broadcast television and movie theaters. The expansion of cable channels gave them a huge new market. On one hand are the traditional programmers: movie studios, television studios and independent production companies. In addition to the traditional companies, there are programmers who produce pay television or pay-per-view programming. HBO, and a growing number of companies like it, produce original movies, sports shows, and television series, or purchase the rights to existing programs. Then they combine these programs into channels, called *premium channels* or *pay channels,* and sell them to distributors. These distributors, called multiple system operators (MSOs), sell the channels to their subscribers separately from the system's basic service. A third type of programmer produces programs that are offered as part of an MSO's *basic package* to subscribers. An example of this type of programmer is the USA Network. It has a complete channel lineup of programming that it sells to an MSO for a small amount (literally pennies) per subscriber. Although the subscriber pays for the channels in a basic cable rate, they are not considered pay channels or pay-per-view programs, since they are included in the basic package.

The distributors, or MSOs, own and operate cable systems all over the United States. In addition to the large MSOs, there are independent systems, but many are disappearing as the MSOs merge and acquire the smaller system operators. Although the major function of the MSO is to operate and maintain cable systems, some are also programmers who produce programs or develop a network of programs and sell them to other MSOs. For example, Jones Intercable, Inc. produces and assembles an educational channel called Mind Extension University (ME/U), which it sells to MSOs and other cable systems.

MSOs also buy and sell cable systems. By structuring limited partnerships, often made up of thousands of small investors, an MSO can buy an existing cable system, upgrade the equipment over a period of years, and increase the value of the system. Then the system is sold to another MSO, often generating a substantial profit for the investors. Because of this method of raising capital, cable television is an industry that is considered to be highly leveraged. This means that large amounts of money are borrowed to buy, build, and upgrade systems, often causing them to operate at a loss for several years. It is not uncommon for a system to operate in the red or with a slim profit for years, and only show a substantial profit when it is sold.

Manufacturers develop and build the equipment that is used to distribute the programs from the MSO to the customer's house. Manufacturers have responded to the MSO needs for higher picture quality, larger systems and greater channel capacity. Since the industry needs are changing and expanding so quickly, each manufacturer engages in research and development activities to meet higher standards and expand the services that cable can provide. As the telecommunications industry, including cable television, expands into new areas, these manufacturers include computer software and hardware companies, telephone manufacturers, electronics companies, and the more traditional manufacturers of cable equipment, including coaxial cable, converter boxes and amplifiers.

But the cable television industry is more complex than programmers, distributors, and manufacturers. Each division is attached to other industries as well. The programmers work with television and film production companies to ensure that the thousands of hours of channel space are filled, seven days a week, around the clock. The explosion in channels from 1 to 100 or more has created a voracious appetite for programming. Companies like Time-Life and National Geographic sell access to their vast libraries of programs to MSOs and other programmers.

The MSOs have connections to industries such as computers, telephony and broadcast television. Many of these alliances in the early 1990's enabled companies who had previously been competitors to work together and exchange ideas. In addition, they were able to experiment with expensive new technologies by sharing costs.

Government Regulation

Until 1984, the cable industry was regulated under the provisions of the Communications Act of 1934. Under it, cable television was treated differently than broadcast television, and therefore cable executives felt it was constrained and unable to expand to meet the needs of the public. In 1984, Congress passed the Cable Communications Policy Act, which deregulated the CATV industry and gave it equal status with the broadcasting industry. Deregulation enabled the CATV companies to determine programming and set rates for cable services that would generate the money needed to expand. And expand it did.

In the mid to late 1980's, MSOs engaged in fierce competition as they bid to wire the cities and towns with the largest potential for subscribers. Often the franchises were granted by municipal or county governments after long and arduous negotiations with several MSOs. In large cities, the sale of franchise rights was worth millions of dollars to both the cities and the MSOs. Small towns and rural areas, where sparse populations required miles of cable to be built to serve a few customers, were passed up by the larger MSOs.

By the late 1980's, most of the large U.S. cities were wired for cable. With the wiring complete, many MSOs turned their attention to acquisitions and mergers. This period of development created some upheaval for the industry and its customers, who at times were confused about what company was operating their system. When customers weren't wondering who was operating the system, they were wondering what happened to their favorite channels.

Coupled with the activity of the MSOs was an equally frantic and bewildering expansion of channels. With only so much channel capacity and an expanding list of programming, systems changed their channel lineups and names and they added and dropped channels in search of a mix that would be attractive to viewers.

Programmers had latched on to the concept of *narrowcasting* and were creating channels that catered to very specific needs, markets, ages, religions and ethnic groups. In addition to new channels, MSOs and programmers began offering new services to the customer. Cable FM radio was available in a variety of formats from country to jazz to classical. Home computers were connected to cable to allow customers to access a variety of teletext information services.

In one sense, the cable industry had achieved its goal to transcend being just another utility and had become an entertainment necessity. When people were hooked up to cable, they announced to their friends, We've got cable TV! Technological advances enabled MSOs to expand the size of the systems, increase channel capacity, improve signal quality, and ensure greater reliability. But the pendulum of regulation began to swing back, and by the end of the 1980's there was pressure to reregulate the CATV industry.

In 1992, Congress passed the Cable Television Consumer Protection and Competition Act, commonly called the Cable Act of 1992, which actually reregulated the industry. The major provisions of the Act focused on four areas:
1) Programming. The Act upheld the public, educational and governmental (PEG) channels; required cable systems to carry the signals of local broadcast television stations; and allowed broadcasters to receive compensation from cable systems who carry their signal.
2) Technology. The Act directed the FCC to study the problem of compatibility between cable systems and consumer electronics.
3) Consumer issues. The Act provided for the regulation of basic cable service rates, including installation, equipment rental and additional outlets; established what a cable system could and could not charge customers for; and established minimum standards for customer service.
4) Competition. The Act prevented local broadcasters from owning a cable system in their service area and cable operators from owning a multichannel multipoint distribution service (MMDS) or satellite master antenna television (SMATV) service in the same area. It also prevented telephone companies from providing CATV service within their service

areas and CATV companies from providing telephone service in their franchise areas. In addition, the Act prohibited exclusive franchises and enabled franchising authorities to grant more than one franchise in their areas; eliminated rate regulation in areas served by two or more competitive cable systems; and prohibited the CATV industry from engaging in unfair competition with direct broadcast satellite (DBS), an expanding wireless technology.

New Alliances
One important result of the Cable Act of 1992 was the formation of alliances between cable and telephone companies. Since virtually every home in the United States had telephone service and over 60% of them had cable service, both industries were vying for control of the one wire that perhaps would someday bring video, data and telephone services to the customer. But they also began working together to overcome the technological limitations that each faced. Since neither industry can afford to spend the $100 to $300 billion required to replace the millions of miles of existing cable and wire in their systems with fiber-optic cable, both are in hot pursuit of the magic blend of coaxial, twisted pair and fiber optic that would enable each one to be the primary service provider.

In the early 1990's, U.S. cable and telephone companies responded to the deregulation of foreign telecommunications markets. They went outside the United States to build partnerships with each other and explore new working relationships. In pilot programs, cable television companies are providing telephone service in areas where they do not have cable systems and telephone companies are providing cable service outside of their service areas. When Southwestern Bell (now SBS Communications)--a regional Bell operating company (RBOC)--bought Hauser Communications in 1993, it was the first of many buyouts, mergers, and partnerships between cable and telephone companies.

This new trend is also producing strategic alliances between the various industries that support cable and telephone, as well as manufacturers of computer software and hardware. Just as programmers compete for viewers and MSOs for customers, manufacturers are fighting for a technological edge that will create a predominate standard for the new, as yet unnamed, industry.

The cable television industry has emerged as a major player in the national goal to build a U.S. network that connects television, computers and telephones to form what is called the *information superhighway*.

Technological Convergence
Convergence is the trend to connect every electronic device to every other one, digitize its input and output, then computerize all of it to create an integrated system. Beginning in earnest in the early 1990's, convergence began to drive the cable industry. Convergence created sparks in virtually every electronic industry, including computers, telecommunications, entertainment, cable television, broadcast television and consumer electronics. The convergence trend has even drawn in publishers, who have products and information services that can be delivered electronically directly to the home, and education, which could provide interactive courses to students outside of the classroom. Convergence is creating strong competition and cooperation between companies and industries. If consumers can only hang on for the ride, in the end the information superhighway may pass directly through their living rooms and open up a new universe of information.

Perhaps the most influential factor in the growth and success of the cable industry is public acceptance. Some studies have shown that a majority of consumers do not desire a fully integrated, converged delivery system for telephone, cable and computer services. However, other studies show that 86% of the public will use the new technology. Many have grown weary of the catch phrase, It’ll make your life easier, especially when only a small percentage of Americans can program their VCR to record a television program while they are absent. In a society where most VCRs flash 12:00 year after year and *channel surfing* has become a national pastime, the computer, telephone, and cable industries have a tough sell to convince people to digitize and automate their lives.

Since 1948, and most dramatically in the years from 1984 to 1995, the cable industry has matured. From the minds of renegades, entrepreneurs and mom and pop companies, an industry has sprung into existence to span the globe and bring a vast menu of communications and programming into the home. From 1948 to 1958, the CATV industry grew to 525 cable systems that provided service to 450,000 customers. By 1994 there were 11,600 cable systems serving 56,000,000 customers in 33,000 communities.

Thousands of people and hundreds of billions of dollars are involved in expanding the technology and what it brings to consumers. Someday we may sit at home and watch holographic football games or ballets, take part in virtual reality entertainment, renew family ties with video family reunions, and play games with opponents in other countries. But perhaps the greatest challenge for the CATV industry will be helping customers understand and use all of the options that will be open to them. When customers know and understand the technology and how to use it, watching or interacting with television will become as easy and familiar as sitting down and turning on the tube.

u contributed by Paul Stranahan

Cable Television: How It Works

Cable television works by sending television signals through a coaxial cable directly to television viewers rather than by broadcasting signals over the air.

There are two ways to send television and radio signals. One method is to send signals through the air, which is known as broadcasting. Any television or radio set within range of these signals can receive them. Another way to send the same signals is to route them through a cable. Only those televisions and radios linked to this cable can receive signals. This is referred to as cablecasting, although some people still use the term broadcasting to refer to television signals sent through cable as well as those signals that are sent through the air. To understand more specifically how television or radio signals are sent through a cable wire, it is necessary to understand each component of a cable system.

There are five major systems involved in cable transmission: antenna, transportation, headend, distribution and drop . These systems work together to move television signals from a program network, such as HBO, to one's home. Though these signals travel thousands of miles, they are able to reach their destination in a matter of seconds.

Antennas
The antenna system is the first part of cable television operation. Antennas pick up television or radio signals broadcast through the air or through outer space via satellite transmission. Off-air antennas receive only those signals that are broadcast over the air. These are the same signals that any television can pick up through its tuner. Cable systems use large off-air antennas constructed on towers to pick up these signals, which are included in the basic cable subscription package. Many cable providers also capture radio signals with their antennas.

Earth station antennas, often called satellite dishes, are powerful antennas that pick up television or radio signals that are transmitted by satellites orbiting the earth. Satellite-transmitted signals reach a wider area than is possible by simply broadcasting signals from a land-based tower. This is because broadcasters beam their signals to a satellite orbiting the earth, which then beams the signal to satellite receivers located at many points within a targeted geographic region. The area that a satellite covers with its signal is called a footprint.

Transportation System
In order to keep the signals that antennas pick up from getting garbled with the multitude of other signals found in heavily populated areas, antennas are often kept in remote locations. To link the antennas to the site (called the headend) where the signals are sorted out and sent to customers, a transportation system is used. This system uses microwave signals, trunk cable or fiber optic cable to move signals from the antennas to the headend. A microwave system uses high frequency radio signals to send the signals far distances. Trunk cables move the signal through a wire using electrical impulses, while fiber optic cable uses light energy.

Headend
The headend is the central processing unit of a cable system. It houses all the gadgetry that allows signals to reach homes. Television signals are sent here from the antenna via

the transportation system. It is the headend's job to sort them out, combine them onto one cable and send them to customers. The size of the headend greatly varies. Often, a headend is nothing more than a few sheds containing several pieces of critical, automated equipment that can operate without human supervision.

More elaborate headends, however, can be full-sized production facilities, with studios, testing equipment and work space for the cable company's employees. In addressable cable systems, headends have a computer that determines what programs and services viewers have ordered and sends only the correct ones. In non-addressable systems, the headend sends out the same signals to everyone, but has scrambled some of them. A scrambled signal is encoded in such a way that the cable viewer must have special equipment to receive it.

Distribution System

Cable television uses a network of wires, called a distribution system, to deliver TV service to its customers. The distribution system consists of two types of cable. Trunk cables carry signals away from the headend over long distances. Like branches on a tree, feeder cable splits off from the trunk cable to deliver the signal into neighborhoods and residential areas. This cable runs along streets and in backyards, and is the point where individual homes connect (via drop cables) with the community's cable television system.

Today most cable systems use a special type of cable, called coaxial cable, to distribute signals. Although amplifiers must be placed along the cable wires to keep the signal from getting too faint on the journey, coaxial cable is a good way to deliver electrical signals because it allows engineers a great deal of control over the signals. In the future, as cable delivers more than television signals, it is likely that fiber optic cable will become standard in distribution systems. Fiber optic cable can accommodate more information at one time and can deliver signals faster than coaxial cable.

Drop System

A drop system is the final leg in cable transmission. Using wires that attach to the distribution system's feeder cable, the drop system is the part of a cable system that connects individual homes to cable service. The drop system begins at the feeder cable's tap, the connecting point between the distribution and drop systems. The first part of the drop system runs from the tap to the ground block. Though not fail-safe, a ground block helps protect the house from receiving electrical surges that might occur through a lightning strike or other mishaps.

From the ground block, wire is run into the house and to the individual television sets if they are cable-ready. But if the television is not equipped to receive cable signals, a converter box is used. Often called a set-top box, the converter allows the television to understand the cable signals that it receives. In addressable systems, these converter boxes are sometimes interactive, which allows the cable viewer to use the converter box to send signals back to the headend to order special services or programming.

By the time signals are viewed on television they have traveled thousands of miles. The signal starts from a broadcast facility, which beams it thousands of miles into space. It comes back down to a cable system's antenna and travels to the headend, which determines where it should be sent and perhaps scrambles the signal. From there it is shot through a distribution system before finally finding its way through a drop cable and onto a television screen. Remarkably, this journey takes less than a second to complete and results in a high-quality picture.

u contributed by Christopher LaMorte

Cable Television Networks

Cable television networks are those programming services provided by a private cable system operator to its subscribers. They are available to viewers primarily through the cable system. Some of these cable networks may be included for free in the price of subscription and are called basic or expanded basic networks. Others are premium cable networks available at an additional cost.

In the simplest of terms, cable is literally a wire that picks up television signals from an accessible point and transmits the signal directly into individual homes. The intermediary in this endeavor is the cable operator, who provides this service for a fee. Initially, cable service allowed connection from traditional over-the-air broadcast networks to isolated viewers who, because of location, could not receive television signals.

During the 1970's satellite technology was refined and TV networks started using this method to deliver programming to their affiliate stations. In fact, satellite feeds proved to be much more economical than traditional methods. In 1975 Home Box Office (HBO) asked the Federal Communications Commission (FCC) for permission to use a satellite to deliver its signal to cable television systems. Radio Corporation of America (RCA), parent of the National Broadcasting Company (NBC), leased space on one of its satellites to HBO, and this allowed the young cable network its first opportunity at economical national distribution. At the time, the three established national television networks were so powerful in their domination of the medium that RCA and NBC saw no reason to fear such a small entity as HBO.

Many of the areas of the country did not need cable in order to receive clear television signals, but the only way cable operators could increase profits was to expand into some of these already accessible areas. Programming provided by the new cable networks offered the operators a means to provide expanded services and choices. As the number of new cable networks multiplied during the 1980's, deeper cable penetration started to erode broadcast TV network viewership. As cable continued to grow, it did so in a rather backwards way. Small and medium markets were the first to be hooked up and receive these new networks. As more and more innovative networks went on the air and the only way to receive them was through cable, larger markets started pushing for cable services in their areas, too.

Today the cable networks can be categorized into types of services, such as sports, music, education, shopping, movies and news. The near future promises even more narrowly targeted audiences defined by such criteria as preferred specific sports, viewer age, ethnicity, hobbies, and other features. Cable networks draw much smaller audiences than traditional networks, but part of that is by design. Niche, or narrowly targeted, programming can be very cost effective for cable network owners. Cable networks are often less expensive to operate and get revenue not only from advertisers but from cable operators as well. This fact was not lost on the traditional television network executives, who continually pushed the FCC for more regulation parity between broadcast networks and cable networks and won major steps towards that goal with regulations passed in 1992.

Basic Cable Networks
Basic cable networks are usually offered at no additional charge to the basic service fee in order to lure cable subscribers. Some of the most notable include:

Arts & Entertainment (A&E) — A&E offers programs, with art and culture selections, to viewers with relatively more education and more income. A&E was launched in 1984 and today is owned by the Hearst Corporation, Capital Cities/ABC, and NBC. Comedies, dramas, documentaries, dance and theater shows comprise the bulk of A&E's air time. A large percentage of A&E's programming is purchased from the British Broadcasting Company (BBC). A&E competes with Public Broadcasting Service (PBS) for audiences.

Black Entertainment Television (BET) — BET is the first cable outlet that offered programs exclusively for African-Americans. Founder, CEO and majority shareholder, Robert Johnson started BET in 1980. BET is an excellent example of cable narrowcasting to a potentially large audience. The network features gospel and rap music videos, movies, college sporting events and several syndicated situation comedies, all of specific interest, either through content or performance, to African-Americans.

Cable News Network (CNN) — Founded by Ted Turner in 1980, CNN has gained world-wide respect as a source of news and information on an up-to-the-minute basis. The bulk of CNN's coverage is general news, but it also programs regular international, political, health and entertainment news as well. CNN cemented its number one news ranking during the Gulf War in 1990. Because of CNN's worldwide logistical connections, reporters, support staff and satellite connections, it was able to bring the most information to viewers and military personnel most quickly. CNN has a sister network, Headline News, which consists of a 30-minute rotating quick news show. CNN is owned by Turner Broadcasting System, Inc.

The Discovery Channel (Discovery) — Discovery could be called the non-fiction network, since its programming consists entirely of documentaries. The documentaries range from historical to scientific to exploration, and most are either produced by the network or are new to American viewers. Its programming, combined with a rather large inventory of environmental public service announcements, makes Discovery a credible voice in world ecological concerns. Launched in 1985, Discovery is owned by New York Life Company, Allen & Company, Group W, Cox Communications, TCI and other investors.

Entertainment and Sports Programming Network (ESPN) — The network's content is sports: sporting events, sports talk shows, sports news shows and sports commentaries. The majority of sports coverage is of broad-appeal sports, such as football and baseball, but ESPN quickly gained fame and respect with its outstanding coverage of under-televised sporting events, such as yacht racing. Practically from inception, ESPN became the network to watch in order to get the latest credible and well-delivered sports news. It went on the air in 1979 and today is one of the largest cable networks. It is on nearly every cable system in the country. Capital Cities/ABC, Inc. is the majority owner of ESPN.

Jones Computer Network (JCN) — JCN is about computers. It is designed to make viewers more comfortable with the primary technology of the information age. The programming mix includes news and magazine-style shows about recent developments in the information technology industry and the newsmakers behind them. How-to programs on software and hardware, academic classes and new product reviews are also featured on JCN. JCN is owned by Jones International, Inc.

Lifetime — Lifetime programming targets women. In 1982 Hearst/ABC Video Services launched Daytime network. Also in 1982 Cable Health Network was launched by Viacom. In 1984 the two networks merged and became Lifetime, owned equally by Hearst, Capital Cities/ABC and Viacom. In a continuation of the Cable Health Network's specialized programming, Lifetime aired numerous medical shows, some very technical. The network has spent the last few years phasing out its medical focus while placing more emphasis on women and original programming. Lifetime has found success in acquiring network programming just after broadcast cancellation and before syndication.

Mind Extension University (ME/U) — ME/U was launched in 1987 by Glenn R. Jones, founder and CEO of Jones International, Inc. ME/U is the only 24-hour network devoted to education and learning. The network is a good example of narrowcasting in that it carries programs and telecourses for credit from various colleges and universities. Students register for classes through an 800 number, watch or tape the appropriate classes and interact with a college or university professor through electronic voice mail or bulletin board. Credit and degrees are granted by the participating university. Courses include ten undergraduate and graduate level degree programs; workforce development programs for professionals; language and literacy classes; and computer skill classes.

Music Television (MTV) — MTV primarily airs rock music videos. As disc jockey or DJ is to radio, video jockey or VJ is to MTV. News, game shows, limited programs, event sponsorship and contests are also part of this innovative and irreverent network's mix. MTV went on the air in 1980 and is now owned by Viacom. The network's style is ultra hip and avant-garde. MTV has influenced television commercials, programming and, to a degree, some print media. It has also influenced the music industry as a whole. Music producers provide videos to MTV and other music cable outlets for free because the extra exposure can ensure additional retail sales. MTV has a sister network, VH-1, that airs somewhat softer rock music for older viewers. Versions of MTV are transmitted all over the world.

Nickelodeon/Nick At Nite — Nickelodeon is an aggressive children's network during the day, while Nick at Nite is a nostalgic retro network for adults in the evening. For 14 hours each day Nickelodeon targets children. Mornings and early afternoons are reserved for 2-11 year olds, while late afternoons and early evenings are targeted towards teens. Ten hours of late night and early morning are devoted to Nick at Nite, vintage television with an often campy flair. Nickelodeon has won praise from parents and public service groups for its attention to programming, commercials and social responsibility. Launched in 1979, Nickelodeon is now owned by Viacom.

QVC Network — QVC is a home shopping network and one of the few survivors among the shopping channels that filled the cable systems in the late 1980's. The network is the result of a merger between Quality Value Cable and Cable Value Network. Shopping networks are attractive to cable system operators because they are not only free to the operator, but they pay a commission on sales to the cable operator as well. QVC offers selling shows with hosts and generally sells high quality products. QVC has recently launched a spin-off, QVC Fashion. QVC is owned by Comcast Corporation and Liberty Media Corporation and has been active in recent years in attempted mergers and buy-outs.

Turner Broadcasting System (TBS) — Originally TBS was an Atlanta-based independent television station, WTBS. In late 1976 WTBS started sending its telecasts out across the country via satellite cable systems. This method of delivery, unique for an independent TV station, started a small trend for superstations. WTBS airs movies, syndicated situation comedies, children's shows and sporting events. In recent years WTBS has won acclaim for its original cable movies and productions. WTBS is majority-owned by Turner Broadcasting Systems, Inc., under the control of Ted Turner.

Pay Cable Networks

Pay or premium-cable networks are those programming services for which the subscriber must pay an additional fee to the operator in order to receive the service. Often these networks are bundled together to make the pricing more attractive.

Cinemax — Cinemax's strength is in movies. It airs more movies than any other cable network. It targets its programming to a younger audience. Started in 1980 as a complement to its sister network, Home Box Office (HBO), Cinemax is now programming some original productions in addition to its vast number of monthly movies. Like HBO, Cinemax utilizes multiplexing, which is essentially sending different signals with slightly different programming to different cable systems. Cinemax is owned by Time Warner Inc.

The Disney Channel — While the vast Walt Disney Corporation resources could rely solely on many classic Disney productions, the cable network prefers to program original shows. Cable movies, children's shows, music and entertainment programs, along with a selection of older movies make up the bulk of The Disney Channel's content. On rare occasions, the Disney channel cablecasts one of Disney's classics, such as *Sleeping Beauty.* Although it has been a premium service since its inception, The Disney Channel is moving to reposition itself as part of a cable operator's basic package of programming services.

Home Box Office (HBO) — HBO is the granddaddy of pay-cable networks. Launched regionally in 1972, it went national via satellite in 1975. HBO programming consists of recent film productions and a few select sporting events, such as boxing and tennis. Recently the network won acclaim for its original movies, situation comedies, music and comedy specials. Partly to preserve its lead in the cable industry and partly to explore emerging technology, HBO often experiments with innovative, collaborative relationships with the cable industry and other networks. Frequent exclusive agreements with major film studios and a feed technique called multiplexing are just two of the areas that HBO has explored. HBO is owned by Time Warner Inc.

Showtime — Showtime, owned by Viacom, started just a year after HBO and is in direct competition with that network. Showtime's aggressive movie programming is very similar to HBO's, but in the recent past Showtime has expanded into some original programming, such as situation comedies, dramas and original movies. Showtime's sister-network, The Movie Channel (TMC), and parent Viacom are very aggressive in obtaining and producing movies in order to enhance their appeal to viewers.

u contributed by Michele Messenger

Cable Television Laboratories, Inc. (CableLabs)

A non-profit research and development organization dedicated to the technological advancement of the cable television (CATV) industry. It serves participating member cable companies in the United States and Canada. Through its affiliation with these companies, CableLabs currently represents more than 85 percent of the subscribers in the United States, 70 percent of the subscribers in Canada, and 10 percent of the subscribers in Mexico. Based in Louisville, Colorado, it is considered the think tank of the cable television industry.

The concept of creating a research and development organization within the cable television industry that would serve all participating member companies is credited to Boston-based Richard Leghorn, television entrepreneur and President of Magnascreen Corporation. Following a vote of approval by the members of the Board of Directors of the National Cable Television Association (NCTA), CableLabs was founded in May 1988. The first order of business for CableLabs' newly appointed Board of Directors was to implement an executive search and name a president.

In August 1988, the Board named Dr. Richard R. Green as President and Chief Executive Officer. Prior to joining CableLabs, Dr. Green was Senior Vice President of Broadcast Operations and Engineering at the Public Broadcasting Service (PBS) in Washington, D.C. Dr. John Malone, President and Chief Executive Officer of Tele-Communications, Inc. (TCI), is Chairman of the Board of Directors for CableLabs.

With a staff of more than 50 people, CableLabs concentrates on work within the cable television industry in four areas: Technical Development, Engineering and Laboratory Testing, Communications and Technology Transfer, and Advanced Television Research.

The CableLabs Technical Development department has been a forerunner in the area of television network architecture design and is taking the lead in exploring how cable systems will offer services in the future. Its Engineering and Laboratory Testing department has been instrumental in working with private-sector manufacturers of television equipment to develop digital video compression techniques.

In 1994, CableLabs completed construction of its own on-site laboratory test facility. The lab will allow for more in-depth testing. One of the primary projects to be undertaken by CableLabs is digital video system conformance testing. The research will determine compatibility of different vendors' digital bit streams and decoders. (Bit streams are delivery systems of video data.) The results of this extensive testing will benefit cable television viewers with better quality images and more cost-efficient delivery of services.

CableLabs shares the results of its research projects with its members in both the United States and Canada through a variety of forums. In 1993, CableLabs held its first CableNET. It was presented in conjunction with the Western Cable Show, held annually in California. The demonstrations presented at CableNET are a collaborative effort among CableLabs and industry manufacturers.

The Advanced Television department of CableLabs is continuing to work with the Advanced Television Test Center, Inc. (ATTC), in Alexandria, Virginia, as a field test site for the new U.S. advanced television (ATV) standard developed through the Grand Alliance. According to Peter Fannon, Executive Director of the ATTC, the primary goal of the Grand Alliance has been to research and develop, through a collaborative effort, the new U.S. ATV standard. The new ATV standard is important to the cable television industry because CATV is a primary delivery system for broadcasting.

Development of a new U.S. ATV broadcast standard actually began in 1987 with the formation of a special Federal Communications Commission (FCC) Advisory Committee on Advanced Television Service (ACATS) headed by Richard Wiley, former FCC Chairman. After establishing its goals, the committee invited qualified participants to compete in designing an advanced television standard that would allow for the broadcasting of high definition television (HDTV). In the midst of the development process, the participants realized that the industry was moving very quickly from an analog delivery system to digital. Areas such as computing power, digital memory, and digital compression had a decided impact on their work.

As a result, early in 1993 after years of development, four of the five systems presented for evaluation were all digital. Following extensive testing and analysis of the results, the FCC Advisory Committee concluded that the four all-digital systems, out of the five presented, were very good, and held great potential for delivering HDTV. It was expected that the FCC Advisory Committee would then request additional laboratory testing before selecting one clear winner. However, the participants developing the four advanced digital broadcast systems subsequently announced on May 24, 1993, that they would work together cooperatively. Thus, the Grand Alliance was born.

The private corporations and research organizations that are participating in the Grand Alliance are American Telephone & Telegraph (AT&T), General Instrument, the Massachusetts Institute of Technology, Philips Electronics North America, the David Sarnoff Research Center, Thomson Consumer Electronics, and Zenith.

Dr. Green anticipates that CableLabs will field test the results of the new U.S. ATV standard developed by the Grand Alliance in June 1995. Once approved, the new ATV standard will allow for the broadcasting of HDTV to the home cable television viewer. This new standard will replace the existing National Television Standards Committee (NTSC) standard. The FCC is slated to approve the results and mandate the new ATV standard by late 1995. However, the time necessary to award broadcast licenses and begin marketing in-home television sets that receive the new HDTV signal is uncertain. It is important to note that, in today’s world of converging technologies, the leading computer manufacturers in the United States clearly prefer the soon-to-be announced advanced television standard.

In addition, CableLabs is conducting ongoing research in other areas related to HDTV. CableLabs has been involved in researching this new system because the architecture of cable systems must lend itself to delivering HDTV to the cable subscriber. The viewing experience of HDTV is a dramatic improvement over current television. This is because both sound and pictures are significantly enhanced. Touted as the format of the future, HDTV cable networks have been a continuing project for CableLabs since its inception.

CableLabs also is researching the combining of telephone services with cable television services, known as cable telephony, which would be delivered through one connection to a subscriber’s home. In mid-1994, CableLabs issued a request for proposal (RFP) for telephony hardware and software. This RFP was sent to more than 100 vendors on behalf of six of CableLabs’ cable television member-companies: Comcast Corporation, Continental Cablevision, Cox Communications, Tele-Communications, Inc. (TCI), Time Warner Cable, and Viacom International, Inc. It is anticipated that cable companies would offer basic service first, and, over time, install high-speed data service and video telephony service equipment. Interoperability is a key criterion for vendor selection. Testing of these systems will be conducted at CableLabs’ facility in Louisville.

Truly a unique entity, CableLabs was created to help the cable television industry develop not only high-quality, but also highly efficient and cost-effective systems for cable television companies. This research ultimately benefits all cable subscribers. CableLabs foresees two-way interactive services to homes with cable. It’s not inconceivable that cable viewers of the future will be able to order dinner from a favorite neighborhood Chinese restaurant using their cable system. After screening the menu and viewing the daily specials on their home television, viewers will place an order via a keypad. The restaurant will deliver dinner within a few minutes to the subscriber’s front door. Chopsticks, however, will still be optional.

u contributed by Valerie Switzer

Cables and Wires

Conductors of electrical power, electrical signals, light and radio frequency (RF) signals that are used extensively in the computer, telephone and cable television industries.

In order to get electrical power signals or an optical signal from one device to another, a path must exist that connects them. The generic term, *transmission medium*, refers to this path. In the computer, telephone and cable television industries, a common transmission medium is a metallic conductor. The most practical conductor is copper; however, copper is expensive and can be replaced by copper-cladded (coated) steel or aluminum, especially where extra strength is necessary. Conductors can be solid or they can be twisted wires. In fiber-optic cable, which is commonly used in all three industries, the transmission medium is very small diameter strands of clear glass.

Types of Metallic Cable

Coaxial cable, called coax, is used to carry electrical power and radio frequencies (RF) . Coax (pronounced *co-ax*) gets its name from the two conductors that share the same axis, the outer conductor surrounding the center conductor. The *center conductor* is a solid conductor of copper or copper-cladded aluminum or steel that is surrounded by an insulating material called a *dielectric*. The dielectric is a non-metallic material that insulates the center conductor and separates it from the *outer conductor*. The outer conductor surrounding the dielectric is made of either a solid metallic material or braided or woven copper strands. It also functions as a *shield* to prevent signals from entering the cable, called ingress, or exiting the cable, called egress.

For direct current power, the outer conductor provides the return path for the electricity, completing the circuit. Outside of the braided conductor is the *jacket* that protects the conductors from moisture, dirt and abrasion. Jackets are often made of polyethylene, polyvinyl chloride (PVC) or non-contaminating vinyl. For some special applications, the jacket may be covered by a steel armoring to protect it from being bent or collapsed.

Some coax, such as that used in cable television (CATV) systems, also includes a second conductive shielding made of a metallic material, generally thin aluminum foil. It is wrapped around the dielectric, then covered by the braided outer conductor, giving the cable a very good shield against ingress and egress.

Coax comes in a variety of sizes and types, depending on the distances the signal travels, the weather conditions that are most common, whether the cable will be used inside or outside, and in CATV applications, whether the cable distribution system is aerial or underground and whether the cable is used in the trunk, feeder or customer drop. In CATV systems, the trunk is the portion of the distribution system that transmits the signal from the headend to neighborhoods, the feeder takes the signal from the trunk into the neighborhoods, and the drop takes the signal from the feeder to the customer’s house.

RF signals decrease in power (amplitude) as they are transmitted along a cable. The process of losing power is called *attenuation,* and it is worse in small diameter cable than in large diameter cable. For this reason, in CATV systems larger coax is used for trunk and feeder lines where the signal must travel longer distances. Customer drops are often short, so small diameter coax is used there and for the short jumper cables that connect to television sets and VCRs.

Moisture is an enemy of all signals, so coax cable that is used in damp climates or buried underground often includes a gel that forms a protective barrier against water and vapor.

Outside cable is made of special materials that provide additional protection from ultraviolet rays, which can make the jacket brittle, causing it to crack and let moisture in. Cable used indoors does not require ultraviolet protection; however, the jacket of interior cable must include a fire retardant and must be made of a material that will not emit toxic vapors when it burns. Because aerial cable is strung from pole to pole, it must be strong enough to support its own weight and the additional strain of snow and wind. To support aerial trunk and feeder cable, a separate steel cable, called a *messenger*, is attached to the outside of the cable.

Coax is used in cable television systems because it has the capability to transmit a broad bandwidth signal. Today, each television channel is 6 megahertz (MHz) wide, so to carry 50 channels a cable must be able to transmit a bandwidth of at least 300 MHz. Most modern cable systems are 550 MHz in size, and some are 750 MHz. Coaxial cable is one of the strongest, lightest and most economical transmission mediums for broadband signals. It is also used in telephone networks because it can carry more conversations than normal telephone wire.

Wire

Telephone wire is composed of two copper strands that are twisted together. A twisted pair (TP) is required to complete the circuit and allows a signal to be sent in both directions simultaneously. One voice channel, or circuit, requires about 4 kHz of bandwidth and is carried by a pair of wires. Since signals are carried in both directions by one TP, the circuit is called duplex (sometimes referred to as full-duplex). Four-wire circuits, with one TP used for transmitting and one TP for receiving, also support duplex transmission. Duplex transmission has the capacity to transmit in both directions simultaneously. All long distance wire circuits use two TP (four wire), and most local circuits use one TP.

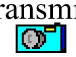
The twists in the wire reduce the transfer of energy from one pair of wires to another, called *inductive coupling,* or *cross talk*. The twist ratio is the number of twists per inch. In multipair cable, which has up to 3,000 twisted pairs, the wires have varying twist ratios and sometimes reverse twists to randomize the inductive coupling and cause less cross talk between pairs.

Like coaxial cable, a twisted-pair circuit also attenuates the signal. For example, on a twisted pair circuit of 22 gauge copper wire, a 2,804 Hz signal is attenuated 1.5 decibels (dB) over a distance of one kilometer.

Unshielded twisted-pair (UTP) is made of 22 or 24 gauge wires and is susceptible to interference currents in devices like fluorescent lights. The Electronics Industry Association (EIA) has established five categories of UTP wiring. Categories 1 and 2 are low-grade and used for voice and low-speed data transmissions. Category 3 is used for frequencies up to 16 MHz and for voice and data transmissions at speeds up to 10 megabits per second (Mbps). Category 4 UTP is used for frequencies up to 20 MHz and for voice and data transmission speeds up to 16 Mbps. Category 5 UTP wiring, called data-grade twisted-pair (DTP), is used for frequencies up to 100 MHz and for voice and data transmission speeds up to 100 Mbps.

Shielded twisted-pair (STP) can carry a broader bandwidth than UTP. STP shields each twisted pair from one another and protects against interference from outside sources.

While telephone twisted-pair wires are designated in five categories, computer twisted-pair wires are designated in nine types, depending on whether they are used for data or voice transmission. Type 1 is made of two TP and is used for data. Type 2 has two TP for data and four TP for telephone. Type 3 is four UTP and is used for telephone. (Type 4 is reserved for future applications.) Type 5 is fiber-optic cable, made of two fibers, one that is 100 micrometers (100 millionths of a meter) in diameter and one that is 140 micrometers in diameter. Type 6 is two TP of stranded, not solid, conductors and is used for patch cords. Type 7 is one TP of stranded conductors and is also used for patch cords. Type 8 is a cable used underneath carpeting for data transmission. Type 9 is two TP of either solid or stranded conductors and is used when data transmission lines must run inside of heating and air conditioning duct work.

Fiber-optic Cable
Made of extremely pure glass, a fiber-optic cable is capable of transmitting over 30,000 times more information over longer distances than copper wire  . The bandwidth of single-mode (one light ray) fiber is several gigahertz. Multimode (multiple light rays) fiber bundles have between two and 144 fibers and a bandwidth of 200 to 500 MHz for each fiber. Unlike other transmission mediums, fiber-optic cable is immune from interference by outside signals and voltage surges, such as those from lightning strikes. Since electrical current is not carried by fiber-optic cable, it can also be used safely in explosive environments.

The fiber core, which is smaller than a human hair, is surrounded by a thin layer of glass, called *cladding,* which has a lower index of refraction and is less reflective than that used for the core. Light rays that enter the fiber at an angle are refracted into the cladding and are lost. Light that is inserted into the fiber at a near zero degree angle (parallel to the fiber) is refracted and the light wave propagates or travels within the glass over 40 kilometers.

The light injected into fiber-optic cable comes from either a laser or a light emitting diode (LED). LEDs are less powerful than lasers, but are also considerably less expensive than lasers, so LEDs are used for short distances, and lasers are used for long distances, where their greater power is needed. The laser light used to carry long distance communication signals has enough power to burn human tissue.

Single-mode fiber is 10 micrometers (10 millionths of a meter) in diameter and allows only a very thin light ray to travel along a strand of fiber. Multimode fiber is 50 to 100 micrometers in diameter and allows a relatively thick light ray to travel along it. The size of fiber-optic cable is expressed as a combination of two numbers; for example 10/125. The first number is the diameter of the glass core, and the second number is the diameter of the cladding, both expressed in micrometers.

Just as other kinds of cable attenuate the signal, fiber-optic cable attenuates the light waves. Single-mode fiber has an attenuation of 0.2 to 1 dB per kilometer. Multimode fiber has an attenuation ranging from 1 to 4 dB per kilometer. As light travels along fiber-optic cable, the wavelengths of the light get longer, a process called dispersion. Chromatic dispersion is the change in color of the light as it propagates down the fiber.

Fiber is protected and given added strength by the use of a protective coating. In most cases, the glass fiber is also surrounded by a buffer that protects it from outside forces. Fiber-optic cable that is used outside is loose buffered so that fluctuations in temperature do not cause the fiber to crack. The fiber lays loose inside a tube that is surrounded by the buffer material. Outside fiber is used for various applications, including aerial, underwater or underground, where the fiber is buried in a conduit or buried directly in the soil.

Fiber used inside is tight buffered. The fiber is bound to the buffering material and can be used in heating and air conditioning duct work or when it must run vertically between the floors of a building.

Composite cables, which are made up of both fiber-optic strands and copper strands, are used for existing low-speed data communications and future expansion. When fiber is laid that will not be used immediately, it is called dark fiber, meaning that it is not carrying light.

Care must be taken when bending fiber-optic cable; however, depending on its diameter, it can be bent to a radius of no more than 20 centimeters. Fiber can also be spliced together with connectors, clamps, or by fusing two ends together by melting the glass.

Although fiber-optic cable can be made of plastic, its attenuation is 200 dB per kilometer and it does not transmit some wavelengths — for example those that are required for local area networks (LANs).

Summary
Each transmission medium has been developed to allow for the efficient delivery of signals between a transmitter and a receiver. Each has factors that are seen as advantages by one industry and as disadvantages by another. For example, the cable television industry sees the capacity of coax cable as limited for its broadband signals, and the telephone industry sees coaxial as a transmission medium with virtually unlimited bandwidth for its narrowband signals. Coax, twisted-pair and fiber-optic cable will continue to be mixed and matched in hybrid networks that provide the communication links and services that people will pay for.

u contributed by Paul Stranahan

Cablevision Industries Corporation (CVI)

Founded in 1956 by Alan Gerry, Cablevision Industries Corporation (CVI) is one of the ten largest cable television operators in the United States. Its headquarters are located at One Cablevision Center in Liberty, New York.

Following his discharge from the United States Marine Corps, Alan Gerry found an ideal career when he started his first cable system in 1956 in Liberty, New York. Situated near the Catskill Mountains resort region, the Liberty system became the cornerstone of CVI.

During the 1960's, Gerry led his company through steady growth, and by 1970, it numbered more than 2,000 subscribers. However, in the 1970's the company began to grow at a very rapid pace. Gerry expanded cable penetration to the areas surrounding Liberty and points beyond into western Pennsylvania. Ten years later, in l980, the company had grown to a total of 52,000 subscribers and earned the ranking of the fortieth largest U.S. cable company. During the past 15 years, CVI has continued to grow significantly.

Technological innovation has been a major component of CVI's success. It was one of the first MSOs to implement amplitude modulated link (AML) microwave technology, which gave the company the ability to integrate multiple headend, large area cable systems. In 1989, CVI completed its first fiber optic installation throughout Los Angeles.

In 1991, Gerry created a separate partnership with the investment firm of Kohlberg Kravis Roberts & Company (KKR) with the sole purpose of acquiring U.S. cable systems. In 1992, it did just that by purchasing the cable system that served Long Beach, California. This acquisition included more than 65,000 subscribers.

In addition, CVI has expanded its services, providing private data transmission for organizations such as Ford Motor Company and Foxboro Corporation. It has also implemented Impulse Pay-Per-View services for its cable customers. CVI is currently in the final stages of installing all-fiber-optic trunk systems in its Columbia, South Carolina, operation.

In 1993, CVI announced that it would upgrade all of its cable systems to utilize new digital compression technology, which will allow cable systems to feed up to 500 channels of programming.

In February 1995, Gerry announced the upcoming merger of Cablevision Industries Corporation with Time Warner Cable, currently one of the other ten largest cable television multiple system cable operators (MSOs) in the country. Time Warner Cable will take over management responsibilities of CVI prior to the close of 1995.

u contributed by Valerie Switzer

Gerry, Alan (no dates available)

Founder, Chairman and Chief Executive Officer of Cablevision Industries Corporation (CVI), Alan Gerry has led CVI since its inception in 1956. A cable television pioneer, Gerry is perhaps best known within the industry for his efforts in 1994 to create a fair arena for competition among mid-sized cable multiple system operating companies (MSOs) and local telephone companies.

In 1956, Gerry built his first cable television system in Liberty, New York, located near the Catskill Mountains resort region. The corporate headquarters for CVI are still located in Liberty. During the 1960's, CVI grew at a steady pace, increasing its subscribers at a moderate level. Growth during this period was primarily through acquiring franchises and building cable systems in the communities surrounding Liberty. By 1970, CVI had grown to 2,000 subscribers.

Realizing that cable television was, indeed, the wave of the future, Gerry began an accelerated plan to expand cable into other areas of northern New York and western Pennsylvania. By the end of 1980, CVI had expanded in size to 52,000 subscribers, and had grown to the fortieth largest MSO in the United States.

In 1991, Gerry formed a partnership with the firm Kohlberg Kravis Roberts & Company (KKR) for the purpose of acquiring additional cable systems throughout the country. In 1992, this partnership bought its first cable system in Long Beach, California. This single acquisition increased CVI's subscriber base by 65,000. Currently, the company operates 64 systems serving more than 1.3 million subscribers in 18 states. CVI's areas of service include suburban Boston, portions of greater Los Angeles and Philadelphia, and areas of New York, Florida, North Carolina, South Carolina and Louisiana.

During the last decade, which saw extraordinary growth in the cable television industry, CVI continued its rapid expansion. By 1994, the company had grown to 1.3 million subscribers. It is currently one of the ten largest cable television operators in the country.

After nearly 39 years of leading CVI, Gerry announced in February 1995 that he had finalized an agreement to merge CVI Corporation with Time Warner Cable, currently the second largest MSO in the country. This merger is slated to be final by late 1995. At the time of the merger announcement, Gerry owned approximately 96 percent of CVI and the Robert M. Bass Group owned most of the remaining 4 percent.

Gerry is an involved leader in the cable television industry. He is a member of the Board of Directors of the National Cable Television Association (NCTA) and serves on its Executive Committee. He is also a member of the Board of Directors of the Cable Satellite Public Affairs Network (C-SPAN) and was a founding member of the Board of Directors of the Cable Alliance for Education. He is a past President of the New York State Cable Television Association. A visible and involved speaker, he often addresses industry groups and serves as a panelist on forums held for members of the cable television/telecommunications industry.

The recipient of numerous awards, Gerry received the 1987 Americanism Award from the Anti-Defamation League. In 1989, he was given the Distinguished Citizen Award from the Boy Scouts of America, and he received the 1992 Entrepreneur-of-the-Year Award from the New England Chapter of the Institute of American Entrepreneurs.

In May 1995, Gerry was honored with the NCTA’s Distinguished Vanguard Award for Leadership. This award was previously known as the NCTA’s Larry Boggs Award, and is still given in his name. In presenting the award, the NCTA noted that Gerry, in addition to his professional leadership qualities, has been instrumental in the construction of a day-care center in Liberty for employees of CVI corporate headquarters and other businesses in Liberty.

A long-standing community leader, Gerry is also a benefactor of numerous groups, including the Boy Scouts of America and Community General Hospital in Sullivan County, New York. He is also a member of the Board of Directors of the Robert Packer Hospital in Sayre, Pennsylvania.

u contributed by Valerie Switzer

Cablevision Systems Corporation

One of the country's top ten multiple system cable operators (MSOs), Cablevision Systems Corporation was established in 1973 by Chairman Charles Dolan. Based in Woodbury, New York, the company currently serves more than 2.6 million subscribers in 19 states. Cablevision Systems is widely known for the many successful programming services it has developed for cable television.

Charles Chuck Dolan, marketing innovator and creator of the very successful cable programming service Home Box Office (HBO), is one of the most successful entrepreneurs in the cable television industry. He began his career in 1965 by launching Sterling Manhattan Cable, the original cable system in New York City. Then he created HBO, the highly successful programming service now owned by Time Warner, Inc.

In 1973, following Time, Inc.'s acquisition of both Sterling Manhattan Cable and HBO, Dolan moved to Long Island, New York, where he bought the existing cable franchise. Dolan, along with John Tatta, former Vice President of Sterling Manhattan Cable, expanded the system and brought cable television to many communities in the area. The newly expanded company became Cablevision Systems Corporation, one of the country's most profitable MSOs. In 1986, the company issued its first public stock offering.

Cablevision Systems is known throughout the industry for its successful development of a number of cable programming services managed under the name Rainbow Programming Holdings, Inc. It produces and distributes BRAVO, a national service featuring international films and performing arts specials, with more than 20 million subscribers. Another programming service, American Movie Classics (AMC), offers a retrospective of the country's greatest films spanning the 1930's to the 1970's and currently has more than 50 million subscribers nationally.

In 1994, Rainbow launched the Independent Film Channel (IFC), the first network completely dedicated to running independently produced films. The company also manages SportsChannel, which operates regional sports channels in numerous top markets including New York, Philadelphia, Chicago, San Francisco, Cincinnati, New England, Florida, and Ohio. In Philadelphia, it operates PRISM, a sports and movie service.

Also in 1994, Rainbow launched NEWSPORT, a 24-hour news and information channel that offers live coverage of the country's most important news conferences about professional sports. Rainbow is also a partner in Courtroom Television Network (Court TV), which premiered in the summer of 1991. In addition, a service titled Romance Classics was launched in 1995.

Not all of Cablevision Systems's programming ventures have been successful, however. It collaborated with the National Broadcasting Company (NBC) in 1992 to combine and market special packages covering a variety of events during the Summer Olympics. Called TripleCast, this innovative marketing venture was not well received by the American viewing public.

One of Cablevision System’s biggest successes, however, is its recent joint venture with ITT Corporation to acquire Viacom’s Madison Square Garden (MSG) and its impressive array of sports and entertainment. With its previous ample offerings of sports programming, this new acquisition gives Cablevision Systems a sizable advantage in the New York sports programming market. For nearly $1.1 billion, Cablevision Systems and partner ITT acquired the Madison Square Garden cable network, the New York Knicks basketball team and the New York Rangers hockey team. The partnership also got the broadcast rights to the New York Yankees baseball team. The company already owned MSG’s primary competitor, Sport Channel New York, which carries the games of the New York Mets baseball team, the New York Islanders hockey team , the New Jersey Devils hockey team, and the New Jersey Nets basketball team.

In addition to creating a number of innovative programming services, Cablevision Systems’s Rainbow Programming also produces the nation’s first 24-hour regional news service — News 12 Long Island, which serves all Long Island cable subscribers. And for fine arts fans, Rainbow Programming offers live coverage of operas from New York’s Metropolitan Opera on a pay-per-view basis.

Cablevision Systems also owns Rainbow Advertising Sales Corporation (RASCO), a regional cable advertising sales company. In addition, it owns Cable Networks, Inc. (CNI), a cable television advertising representative firm.

Dolan and his family hold 10 of the 14 positions currently making up the company’s Board of Directors. Highly regarded in the industry as one of the foremost innovators of cable programming and marketing, Dolan has continually found new ways to develop very successful cable programming services while generating record-setting revenues.

Cablevision Systems Corporation has achieved the highest revenues per subscriber in the country. According to founder Dolan, the revenues generated by Cablevision Systems are an indication of how much programming subscribers are willing to buy. Future plans for Cablevision Systems include development of more programming services to be marketed in new and innovative ways.

u contributed by Valerie Switzer

Cache

An area in a computer's memory that stores frequently used data and reduces the time it takes the computer to access information.

Generally, the word cache (pronounced *cash*) refers to a hidden reserve of valuable materials, or to the materials themselves. In computer lingo, a cache is no different. The valuable commodity that a computer stashes away is data. In order to save time and energy, a computer puts data it frequently needs in a storage location that it can retrieve more quickly than its normal storage location. There are two types of cache that a computer uses, RAM (Random Access Memory) cache and disk cache.

RAM Cache
RAM cache speeds up computer processing by acting as an intermediary between Random Access Memory and the computer's central processing unit (CPU), the part of a computer that handles data and executes commands. Sometimes the RAM cache consists of RAM chips that are faster, more sophisticated and more expensive than ordinary RAM chips. Sometimes RAM cache consists of circuitry in the main processing chip itself.

When the CPU needs data from the program that it is running, the RAM cache volunteers to get that information from slower RAM and hold it temporarily in the faster RAM cache. This slows down computer operation somewhat in the short term (perhaps by a few millionths of a second), because before the cache hands off the data to the CPU, it makes a copy for itself. Its thinking is that if the CPU needed this data once, the CPU will need it again. The next time, instead of reaching all the way back into slower RAM chips to get it, the RAM cache will already have it and be able to give it to the CPU faster. Additionally, the RAM cache makes intelligent guesses about other information the CPU may need from the regular RAM and makes copies of that information as well. The more sophisticated RAM cache chips are, the more accurately they predict what information the CPU is likely to need.

Disk Cache
Although regular RAM is slower than the RAM cache, it is still faster for the CPU to get data from regular RAM than from a disk. That is because a disk drive must physically move a disk to read information. Information from RAM chips is moved to the CPU electronically without any moving parts. Even state-of-the-art disk drives are slow compared to RAM chips. To compensate for the sluggishness of the disk drive, a disk cache serves as an electronic reservoir for disk data. A disk cache can be a specialized software program that tells the computer to set aside regular RAM chips as a disk cache. A disk cache can also be actual circuitry, which unlike disk cache software, does not use valuable RAM space that could be used to store other information.

Like the RAM cache, the disk cache retrieves information requested by the CPU and makes copies of it before giving it to the CPU. The disk cache also copies additional information from the disk because it is likely that the CPU will eventually need this information as well. If the disk cache has guessed correctly about what information the CPU will want, the disk cache saves time because the CPU does not have to wait for information to be pulled off the slow-moving disk. The disk cache also helps speed the process of saving data on a disk. Instead of sending information directly to the disk, the disk cache holds the data until the CPU has a free moment and can spend the time writing the information to the disk. The RAM cache is also helpful in saving data because it is intelligent enough to save only the new information and doesn’t waste time rewriting that which has not changed.

u contributed by Christopher LaMorte

Carrier Systems

Wired and wireless systems that carry the signal to a receiver. Wired carrier systems include cable television and long-distance telephone networks. Carrier waves are used in many forms of wireless electronic communications, including broadcast television and radio, communication satellites, personal communication systems for message paging, and cellular telephones.

A carrier wave is generated by an *oscillator*, a device that produces a consistent, stable radio frequency (RF). Because they vibrate at a specific frequency when an electrical current is applied, quartz crystals are often used as oscillators. The frequency of the carrier is determined by the size and shape of the quartz crystal. Its output varies less than one-hundredth of one percent, and quartz crystals in a vacuum can produce a carrier frequency that is accurate to one-millionth of one percent.

Once a carrier frequency is produced and amplified, the signal to be transmitted is used to *modulate*, or change, the carrier wave. Four common types of modulation used in carrier systems are: amplitude modulation (AM), frequency modulation (FM), phase modulation (PM), and pulse code modulation (PCM).

In AM, an electrical signal from a source, such as a microphone or television camera, modulates the amplitude, or strength, of the carrier wave. When FM is used, the signal source modulates the frequency, or number of waves per second, of the carrier wave by increasing or decreasing it. Phase modulation (PM) is a change in the phase, or timing, of a carrier wave. PCM samples a continuous analog sound wave and converts its amplitude values into a series of pulses to produce the ones and zeros of a digital binary signal.

Modulation of Carrier Waves
Television stations use a variety of carrier waves: very high frequency (VHF) at 54 to 72 MHz for channels 2 through 4; 76 to 88 MHz for channels 5 and 6; 174 to 216 MHz for channels 7 through 13; and ultra high frequency (UHF) at 470 to 806 MHz for channels 14 through 69. The bandwidth for a television channel carrier wave is 6 MHz. The frequency of television carrier waves is controlled to prevent interference with other communications.

PM is used in television to transmit color information in the color subcarrier wave. In PM, the hue and intensity of a color modulate the phase of the subcarrier wave. Hue causes the phase to shift quickly or slowly, and the rate of shift determines the color. Intensity creates various degrees, or amounts, of shift in the phase, resulting in bright or muted colors. Since PM affects the frequency of the subcarrier wave, it is a type of frequency modulation.

PCM is used mainly in telephone and some specialized computer circuits. The PCM signals are used in telephone circuits to carry long-distance phone conversations or in computers to control digital logic gates and circuits that accept, process and transmit data.

In cable television, carrier frequencies function in the same manner as in other electronic communications, however, in cable television there are two significant differences. The first is that a cable television distribution network is a closed system; the carrier frequencies are enclosed in either equipment or cable and therefore cannot interfere with other communications. This allows cable systems to use the same carrier wave frequencies that are in use for other types of free air RF communications, such as mobile radio, aircraft control and emergency communications. However, if the cable network has broken cable or poor connections to equipment, the carrier frequencies can egress, or leak out, and interfere with the carrier waves of radio communications. The same conditions that can create egress can also create ingress. Ingress means that other carrier waves are entering the cable network and are interfering with the carrier frequencies being used by the cable to transmit television channels.

The second major difference in cable television is that coaxial cable can carry multiple carrier frequencies without interference. By maintaining the carrier waves at specific frequencies, dozens of channels can be transmitted on the same cable.

Subcarrier waves are used to transmit stereo sound in both television and radio. A subcarrier is used to carry a special audio channel that is used to produce stereo sound. Subcarrier waves are modulated by a signal, which represents the *difference* between the right and left stereo channels, and by carrier waves, which are modulated by a signal that represents the *sum* of the right and left channels. Transmitted together, they simultaneously represent the mono and the right and left stereo elements.

For voice communications in wired telephone systems, there is no carrier wave. Sound waves in a 4 kHz band are converted into electrical signals in the telephone and are transmitted along the twisted-pair wire, or circuit.

Satellite communications use carrier waves to transmit signals to and from satellites. Satellite carrier waves are in the super high frequency band, ranging from 0.9 to 40 gigahertz (GHz).

Other types of wireless communications, such as electronic paging, cellular phones and a wide variety of mobile and fixed radio services all use carrier waves to transmit signals. The FCC allocates licenses for the use of radio frequencies for carrier waves based on the communication technology and its use.

The use of carrier waves is one of the keys to electronic communications. Since the carrier frequency that is assigned to a television channel or radio station is a constant, virtually unwavering signal, modulation of it by the electrical signal from a source changes it in specific ways. A receiver reconstitutes the original picture and/or sound that make up the message.

u contributed by Paul Stranahan

Carterfone Decision

The Carterfone decision marked a turning point in the monopoly status of the Bell System. In a 1968 landmark case, Carter Electronics won the right to interconnect its equipment to American Telephone & Telegraph (AT&T) lines, opening the way for many other companies to enter the telephone business. This was the first major step toward the development of competition in telecommunications businesses and helped lead to the eventual breakup of the Bell System 16 years later.

During the late 1950's and early 1960's, a number of companies began manufacturing and marketing customer telephone equipment. Since existing tariffs did not permit customers to attach non-Bell equipment to Bell lines, the Bell companies would disconnect any non-Bell equipment that they found and sometimes disconnect the subscribers from the Bell network. At the same time, many customers felt that they had a right to own their own telephones and to hook up any equipment they wanted. The Bell System became increasingly concerned about the technical integrity of its network and its revenues. The issue came to a head in the case of the Carterfone, a device manufactured by Carter Electronics Corporation of Dallas, Texas.

In 1946, Thomas R. Carter started a business that specialized in mobile two-way radio systems. Many of Carter's customers were oil companies that used the radios for drilling crews in remote locations. Often these two-way radio customers needed to talk with telephone users, and going through the base operator as a third party in the conversation was frustrating and nonproductive. Carter set out to develop a device that permitted direct voice communication between persons using the telephone network and those using remote mobile radios. The resulting Carterfone worked by having the radio base station operator establish the telephone call, then place the telephone receiver on a cradle in the Carterfone. A voice control circuit in the Carterfone automatically switched the base radio between transmitting and receiving as the telephone party spoke, permitting a two-way conversation with the party in the field.

The Carterfone went on sale in 1959 and several thousand units were sold over the next few years. During that time, AT&T and the local Bell companies adamantly refused to permit its use over their lines whenever they found it. They contended that hooking non-Bell equipment to their lines could harm the network and cited tariffs that allowed them to refuse service to anyone who was found to have alien equipment attached to Bell lines.

In 1965, Carter filed a private antitrust suit against AT&T, Southwestern Bell (now SBC Communications), and General Telephone of the Southwest, charging violations of the Sherman Antitrust Act. The District Court deferred to the Federal Communications Commission (FCC), saying that the Commission had primary jurisdiction. Since many of Carter's customers were in the oil industry, the American Petroleum Institute spoke out in support of Carter's position. Other endorsements for the Carterfone came from utility companies, the U.S. Air Force, the National Aeronautics and Space Agency, and the National Retail Merchants Association.

On August 30, 1967, an initial decision found against the three telephone companies in almost every particular. The FCC hearing examiner pointed out that the Carterfone put "nothing into the system except the sound of a human voice into the mouthpiece of a handset" and was, therefore, not harmful to the network. However, the examiner also realized that a sudden liberal interconnection policy could have overwhelming consequences to the telephone companies, the Public Utility Commissions (PUCs), and local state regulators. He decided against changing the overall structure of the existing telephone tariffs but ordered the telephone companies to revise their tariffs only so that they would no longer prohibit the Carterfone device.

Despite the moderate decision proposed by the hearing examiner, the FCC went much further in its June 1968 decision. The FCC concluded that the Commission had never approved the AT&T tariff, but merely had permitted it to go into effect, and that the tariff had been unlawful from its inception. The FCC could see no point in allowing only the Carterfone to connect to the system while still restricting all other equipment. Petitions for reconsideration were filed by AT&T, GTE, the National Association of Regulatory and Utility Commissioners (NARUC) and several state regulatory commissions. Opposition to the reconsideration came from many of the same groups who supported the original filing. The FCC reiterated its original decision with the restrictions that, to be approved, a device must fill a significant market need and must not impair the telephone system.

In late August 1968, AT&T revised its interconnection tariff regulations. Per the FCC ruling, the new provisions permitted the direct electrical connection of customer-provided premises equipment, other terminal equipment (such as computers), or customer-provided microwave systems. This equipment interconnection was subject to several restrictions, the most important of which provided that some devices (again, such as computers) could only be connected into the telephone network through a telephone company-provided control device. Another major restriction prohibited the use of any customer-provided device that interfered with network signaling functions. The FCC later upheld this restriction when it ruled that customers could not substitute any of their own telephone instruments, poles, loops, or switching equipment if the same equipment was already provided by the telephone company. Eventually, Carterfone also led to the development of the FCC's current regulations setting standards for devices to be connected to the telephone network. These standards effectively ended the power of telephone companies to control what devices are connected to the telephone network.

The overall result of the Carterfone Decision was that the telephone market was being opened up and AT&T's exclusive hold on the business was being nibbled away little by little. The Carterfone Decision took the first big bite out of the Bell system and set the stage for a radical change.

u contributed by Linda Stranahan

CBS, Inc.

CBS, once formally known as the Columbia Broadcasting System, is the second oldest broadcasting network in the United States. The company is most associated with William Paley, a rich tradition of entertainment, and the company logo, the eye. CBS is headquartered in New York City.

CBS is the middle child. In America’s long-standing three-network system, the National Broadcasting Company (NBC) is the oldest and the American Broadcasting Company (ABC) is the youngest. Middle children, who occasionally have the toughest time finding themselves, sometimes come out the strongest, and that is exactly what CBS is trying to do.

CBS’s Tiffany Network nickname is a bit tarnished these days, with the loss of affiliates, loss of share, and the technology turmoil in the industry. But, like a middle child, CBS is fighting to establish itself once again. The technology turmoil and the related, fast-paced changes are affecting all of the established networks. Howard Stringer, former CBS Vice President and President of CBS/Broadcast Group, said in the 1993 affiliate meeting, I am not afraid of the new technology itself. I do worry about the way this technology is foisted upon an unsuspecting public in the so-called new 500-channel toy land.

Stringer’s dilemmas are very different from Arthur Judson’s. Judson, a talent agent and radio program packager in the 1920’s, just wanted a showcase for his clients. When NBC wouldn’t do business with him, he put on his own show. The under-financed Judson sought a partnership and funds with Columbia Phonograph and Records Company. On September 18, 1927, the new radio network, known as Columbia Phonograph Broadcasting System, went on the air. Each week the network provided 10 hours of programming to 16 affiliates. Judson’s company, United Independent Broadcasters, provided the programs.

The next 15 months were a roller coaster for the young radio network. Columbia Phonograph withdrew from the partnership. Controlling interest was sold to a Philadelphia builder who changed the name of the company to Columbia Broadcasting System, or CBS. In a very short time he was forced to sell CBS due to an injury. The third owner became William S. Paley in January 1929 . Paley is the man most associated with CBS. He did much to change the fortunes of the young network and, in the process, the young radio industry as well.

The 1930’s saw growth and profits for CBS: daytime dramas; big-name stars from film and rival networks; the father of radio news, Edward R. Murrow; and lucrative contracts, including free programs, for affiliates. These were all part of Paley’s plan. CBS’s success led to not only more affiliates but also the first of its owned and operated radio stations. Television was the natural progression from radio and all of the established radio networks made the move.

The feeding chain of corporate America — larger companies buying smaller companies and divesting in other industries — came full circle when, in 1939, CBS bought

Columbia Records Company. The name was changed to Columbia Records, and the company became a leader and staple in the recording industry. Sony bought Columbia Records in 1988 for $2 billion.

Television was nurtured by radio visionaries like Paley. Graphics, decor, and design were to become a hallmark of CBS. The network was classy. Sustained entertainment ratings provided a strong foundation for the company. In a broad sense, CBS was number one in ratings from the 1940's to the mid-1970's. Frank Stanton, another name closely associated with CBS and a visionary, became President of the company in the mid-1940's and, with Paley, made the company a respected success.

CBS used this time of profits and success to buy additional companies in other industries, including cable, film, publishing, toys, sports and musical instruments. In 1974 the name of the company was officially changed to CBS, Inc., although many people still used the Columbia Broadcasting name.

During the 1970's ABC, perennially in last place, focused on CBS's weakness — very little programming for a younger audience. Slowly, methodically and with carefully targeted programming, ABC gained enough share to declare itself number one and CBS a gray network.

For the first time since Arthur Judson's day, CBS was fighting from a decidedly bottom ranking. Not only was CBS losing ratings and revenues, but the public perception of the downward trend seemed practically impossible to turn around. The penetration of cable and home VCR use, in addition to a weakened advertising economy, was forcing all of the broadcast networks to tighten their belts. All three were thrown into a fight that not only were they unprepared for, but also hadn't even anticipated. At CBS, where Edward R. Murrow was the father of radio news, Walter Cronkite was also the trusted television newscaster and his decision to retire in 1981 gave viewers yet another opportunity to test other news sources. By the mid-1980's, when takeover attempts were made by both Ted Turner and Ivan Boesky, CBS was vulnerable. Paley, in an uncharacteristic lack of vision, appointed many successors to himself only to get rid of them later. The result was that many years went by with Paley aging, the industry changing, and a lack of direction. Discontent reigned.

In 1985 CBS's attempts to bury Ted Turner's takeover were successful when the company welcomed Laurence Tisch, president of his family's Loews Corporation and an 11% CBS stockholder. In a matter of months Tisch had purchased twice as much stock as Paley, previously the largest stockholder. Partly in an effort to control Tisch, the CBS board offered him a position on their board. He joined, publicly stated his support for then-President Thomas H. Wyman, and voiced his opinion on the need to keep the company independent. Within months, however, Tisch and Wyman had a falling out, Paley backed Tisch, Wyman left, and when the smoke cleared and the bodies were counted, Tisch had control over CBS, Inc.

In a final effort to regain control of the business, the board voted to sell assets to service the debt. The companies bought in the 1960's and 1970's were sold. The parent company went from 30,000 employees in 1984 to 6,500 in 1993. Earnings per share during this same nine-year period went from $6.59 to $20.39. And while the decline in employees was steady, the earnings per share were a mixed bag during that time period. It was still a rocky road.

From a programming perspective, the losses of Major League Baseball in 1993 and the National Football League's NFC coverage (a 38-year relationship) in 1994 were devastating. Both losses precipitated the exit of many talented folks behind the microphone, board and camera. And then, in a move that stunned the industry, Rupert Murdoch's Fox Broadcasting Company, which had won the 1994 NFL NFC broadcast rights, invested $500 million in New World Communications Group. New World owned 12 affiliate stations in major markets and all of them made the switch to Fox. Eight of the 12 stations had been CBS affiliates.

In early 1995, rumors about Tisch selling CBS went into high gear and it seemed like a valid scenario. Ted Turner, who had tried to buy CBS and other networks in the years preceding, was said to be very, very interested and working his way towards ownership yet again.

These events have caused the Tiffany Network to lose a bit of its luster in the public eye. Businesses of every size, indeed even individuals, learn that every obstacle is an opportunity. There is no doubt that CBS will face future obstacles and opportunities with fierce determination, much like Arthur Judson did on September 18, 1927.

u contributed by Michele Messenger

Tisch, Laurence A. (1923 –)

American businessman and television executive, currently Chairman of the Board, President and Chief Executive Officer (CEO) of CBS, Inc., formerly known as Columbia Broadcasting System. In December 1990, Chairman of the Board was added to Tisch's list of titles. Tisch is also Chairman and co-CEO of Loews Corporation.

The Tisch family consisted of Al and Sayde and sons Larry and Preston Robert, who was called Bob. They lived in Brooklyn. Sibling rivalry was not tolerated between Larry and the younger Bob, and today the brothers are best friends. In 1935 Al, who had a clothing business, bought a summer sleep-away camp. Larry worked at the camp every summer and for his father's clothing business during the school year. He graduated from high school and college early and during World War II used his quick, mathematical mind to break enemy codes for the Office of Strategic Services (OSS).

In 1946 Larry Tisch found a New Jersey resort for sale. His family sold the summer camp to finance the resort, and ran this new venture. Over the ensuing years, the family acquired more hotels. They also acquired wealth and with that wealth acquired Loews Corporation stock. At the time, Loews consisted of the Metro-Goldwyn-Mayer (MGM) studio, movie theaters and real estate. The Tisch family owned 28% of Loews stock when the government forced the Loews Corporation to sell off the movie studio. The Tisch hotels were merged into Loews and Larry was named CEO of Loews.

More mergers, properties and acquisitions took place over the next decades and Tisch honed his management and business style. Then Loews Corporation engaged in a hostile takeover of CNA Insurance Company. The resulting public criticism caused Tisch to avoid hostile takeovers as a future business expansion tactic.

In late 1980 and early 1981, Loews started buying American Broadcasting Company (ABC), but was asked by Leonard Goldenson, Chairman of ABC, to sell the ABC stock. Goldenson and Tisch were former tennis partners and knowing Tisch's feelings and position regarding hostile takeovers, yet being nervous about Tisch's motives, Goldenson asked Tisch to sell the stock. Tisch then began accumulating CBS stock.

Tisch was in a position to take over the network when his family's Loews Corporation increased its percentage of CBS stock in 1985 and 1986. When Tisch finally took control of CBS he started a long, slow turn-around of the network. While CBS had been strong during most of its history, the last few years had been tough on it and the industry in general. Indeed, by the mid-1990's all of the three established television networks were being challenged by deeper cable penetration, new network competition and serious viewership decline. And while all of the established networks would have to settle for smaller pieces of the pie, they weren't about to give up and sell out. Tisch and his colleagues at the other networks started a serious downsizing program at each of their companies.

In late 1993, maneuvering by Rupert Murdoch and the Fox Broadcasting Company (Fox) managed to bring a small disaster upon CBS. Fox bought the television rights to the

National Football League's conference games out from under CBS. While Tisch and his executives were working on plans to fill the Sunday afternoon time period, Fox bought New World Communications Group, 12 network-affiliated stations in large television markets. Eight of the 12 were CBS stations. The loss of so many affiliates in one swoop was panic-producing. Tisch publicly vowed to rebound and thrive, to add affiliates and possibly extend affiliate agreements. By late 1994 and early 1995 the speculation was that both NBC and CBS were for sale with the expectation that CBS would be the first to go. While these rumors have been circulating for some time, the changing environment of broadcast network television makes it anyone's guess as to who will own whom in the coming years.

u contributed by Michele Messenger

Compact Disc-Read Only Memory (CD-ROM)

CD-ROM is a high-capacity, portable data storage medium for computers. It provides convenient access to information that does not require frequent changes or updates.

Compact disc-read only memory (CD-ROM) was first introduced in 1985 as one of many products created by digital recording research conducted during the 1960's and 1970's. Like hard drives and floppy disks, CD-ROM is a medium for storing data that can be retrieved by a computer. However, as its name implies, the information stored on CD-ROM can only be retrieved. It cannot be changed or added to by the user.

CD-ROM discs are similar to audio compact discs in both size and appearance. They also use the same technology to store information. Spiral tracks contain data in the form of binary numbers, or strings of ones and zeros. Level areas on the disc represent zeros, small pits indicate ones. When the disc is placed in a CD-ROM drive, a narrow laser beam "reads" the surface of the disc as it spins. The laser's light scatters when it passes over pits on the disc. When it strikes a level area, it reflects back to a light sensing mechanism that generates a small electrical charge. These charges are then transmitted to the computer.

A CD-ROM disc has a storage capacity of roughly 650 MB, equal to about 1,500 floppy disks. One CD-ROM can contain about 250,000 pages of printed text or up to 10,000 graphic or photographic images. This capacity makes CD-ROM discs ideal for storing reference materials requiring infrequent updating, such as data bases, dictionaries, and encyclopedias. Because of this, most early CD-ROM discs were developed for business applications or for use by libraries and other information centers.

CD-ROM discs are still largely used for publishing and distributing reference titles. However, declining CD-ROM disc and drive prices, coupled with the rapid development of commercial CD-ROM titles, is making this technology desirable and affordable for home computer users as well. Newer CD-ROM titles run the gamut from games that both instruct and entertain to atlases that show every street in the United States. Many now include graphics and sound as well.

u contributed by Sonia Weiss

Cellular Telephones

Wireless telephones that use broadcast radio signals to communicate with radio antennas (base stations) placed within adjacent geographic areas called cells. The base stations, which are interconnected with the public switched telephone network (PSTN), complete the call. Cellular phones allow the user to be mobile, whether by vehicle or on foot, without losing telephone contact.

Cellular mobile telephones were developed by Bell Laboratories in the early 1980's for use in cars and trucks. At first, all of the telephones were connected to a vehicle and used its battery for power. Later, transportable telephones were developed with a detachable battery that allowed the telephone to be removed from the vehicle and carried around. Now, there are also small, pocket-size portable telephones that can either fit into a stationary holder for use in the car or exist as a totally independent unit with a separate recharging base. All three types of cellular phones are currently available.

How Cellular Works

Regardless of the type of cellular telephone used, the process for placing or receiving calls is the same. The most common cellular mobile telephone system (CMTS) consists of a low-powered, radio telephone operating at between 800 and 900 megahertz (MHz) and using multiple transceiver sites that are linked to a central computer for coordination. The geographic area to be covered is divided into cells, often drawn in the shape of a honeycomb, with each cell covering a radius of about 6 to 12 miles. Each cell has its own radio transmitter/receiver. Although adjoining cells operate at different transmitting and receiving frequencies in order to eliminate crosstalk between cells, sets of frequencies can be reused throughout a given geographic area.

When a cellular phone is activated, it searches the available channels for the strongest signal and locks onto it. As the cellular phone user travels from one cell to another, the computer monitoring the cells notices that the signal strength is beginning to fade in one cell and increase in another, and automatically hands off (switches) the telephone to a signal frequency in the next cell. When a call is placed to a cellular phone, the number is broadcast from the cellular service's main computer through a control channel to all of the receivers in the cellular system and is picked up by the receiver that currently has the called phone's signal in its cell.

Analog and Digital Transmissions

Cellular telephone systems have traditionally relied on analog transmission techniques. Analog signals are continuously varying electrical signals that closely resemble (are analogous to) the original sound. During extended conversations with someone on a mobile cellular phone, short pauses and blank spots are experienced as the signal is handed off from one cell to another. These blank spots, while merely annoying during a voice call, could cause serious reliability problems if transmitting computer data. With the development of portable laptop computers and modems that used cellular networks to transmit data, this reliability problem required a solution. In addition, a way needed to be found to more efficiently use the idle portions of the bandwidth that occur in normal voice communications.

So to prevent lost or interrupted data and make better use of the available bandwidth, many cellular companies are now offering a transmission technique called Cellular Digital Packet Data (CDPD). CDPD uses the existing analog cellular network but transmits the data in high-speed digital packets during the normal pauses in cellular phone conversations. The problem of data being interrupted during the signal hand-off is solved by error-checking techniques built into packet-switching technology. If a packet is lost or garbled, it is simply retransmitted. CDPD uses available pieces of the network wherever they are at the moment, allowing the data transmissions to "hop" between channels. By adding CDPD to an existing analog cellular system, cellular operators can reliably transmit data at relatively high speeds without building a new digital network.

Meanwhile, cellular companies are slowly replacing their current analog phone systems with digital cellular. Two digital technologies are fighting to become the national standard: Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). Both can transmit many calls on a single radio frequency. TDMA, the simpler of the two methods, is already in the marketplace and has initial support from several large cellular providers as well as the Telecommunications Industry Association (TIA). Current TDMA systems divide a channel into three time slots, each a fraction of a second. This allows one channel to handle three signals simultaneously. Future systems will accommodate up to seven signals.

But lately, the momentum has shifted toward CDMA, which appears to offer better voice quality, fewer dropped calls, better security, longer battery life, and more capacity than TDMA. CDMA systems use a low power signal spread across a wide-frequency band. Each transmitted signal is combined with a unique code, then spread across the same broad frequency spectrum as all other signals. The dispersed signals are pulled out of the background noise by a receiver that knows the code. Supporting hardware is still being developed and put in place, and, although no systems are currently operational, several cellular operators have already lent their support to this technology.

New Competitors

Not only are the two technologies competing for support from the existing cellular providers, but the cellular companies themselves are facing new competitors as well. Under the original cellular regulations, each geographic area was allowed two cellular operators. One was the local telephone company, the other an independent business. Now, with changes in the regulations, cellular operators are also beginning to face competition from some new players. Three wireless voice/data options, one old and two which are still in the formative stages, will greatly affect cellular service in the near future. These are: specialized mobile radio (SMR), low Earth orbit (LEO) satellites, and personal communications services (PCS).

SMR operators, who had previously handled taxi and truck dispatches, are now looking at expanding into cellular-like phone services. Many SMR operators are converting their SMR networks to digital technology so that they can deliver both voice and data to a single device. SMR systems have far less radio spectrum than do cellular systems, but they can reach 25 times farther than analog cellular, which means the cost of building a network is less. In addition, the SMR call-handling capacity is large and its service costs are projected to be 10 to 15 percent less than cellular. But there are two drawbacks facing the SMRs: they will have to interconnect today's independent systems to create a coast-to-coast wireless network, and much of the existing wireless hardware will not support cellular-like service and will have to be replaced. However, the replacement equipment is much more sophisticated and will support paging, fax, and modem transmissions, as well as high-quality voice. Nationwide roaming is also planned for SMR systems, meaning a telephone can use the same phone number regardless of where it is used in the United States. As SMR systems start looking more like cellular systems, they are beginning to be called enhanced SMR or ESMR systems.

The proposed LEO satellite networks, which could consist of a constellation of a dozen to several hundred satellites, make up the second threat to the cellular industry. These networks of non-geostationary satellites orbiting 500 miles above the surface of the Earth will provide global coverage, including hard-to-reach rural areas in the United States and underdeveloped countries worldwide. Important issues, such as global standards and bandwidth allocations, still need to be resolved. Although some major players are prepared to enter the industry and several have already received FCC approval, it probably will be at least 1998 before a LEO satellite network will be operational. If and when implemented, these satellite networks could provide major competition to the cellular industry.

The third group of contenders for the wireless market, PCS companies, are already beginning to establish themselves. The government auction of radio frequency spectrum, some portions designated specifically for PCS, has thus opened the door for the growth of PCS. This digital technology lets users make calls from small, lightweight pocket phones and send messages from tiny computers called personal digital assistants (PDAs). PCS networks use microcells with a radius of no more than 400 meters, resulting in thousands of tiny radio transceivers in a city, and operate at higher frequencies than cellular systems. The networks still have to be built; but with the auction of the new frequencies, it is only a matter of time before they will be operational.

Summary

In the last ten years, cellular telephones have gone from relative obscurity to common items. Although originally used only by a select few, their popularity has soared as they have become smaller and more affordable. The market is poised for another big change as additional competition looms on the horizon and new technologies are introduced. The cellular telephone industry may go through another complete metamorphosis during the next ten years.

u contributed by Linda Stranahan

Central Office

A telephone company facility where customers' lines (both residential and business) are connected through the public switched telephone network (PSTN) to other customers' lines for either local or long distance service. The term *central office (CO)* means the same thing as the overseas term *public exchange*, and the original central offices in this country were called exchanges. As the technology has changed over the years, a central office has evolved from a simple switching center serving the function of a large switchboard to a computerized switching center that accommodates telephone conversations, high-speed data transmissions and some video signals.

A telephone customer is usually connected to the central office by way of a two- or four-wire loop. The telephone number dialed by the customer indicates to the switching equipment the destination of the call, and the central office connects the telephone to another telephone in the same area or to an appropriate outgoing trunk line. Depending on the call's destination, this connection may be on wire cable, fiber-optic cable, or via microwave radio signals.

Central offices are usually designated by the type of switching equipment they use. Older *step-by-step* and *crossbar* offices used noisy mechanical switches. Almost all central offices in the United States now use some form of *electronic switching* that are, in reality, highly complex computers.

History
Immediately following the development of the telephone in the late 1870's, it became obvious that subscribers' lines in an area should be brought together at one common point where connections could be made. The first commercial telephone switchboard (exchange) began serving 21 customers in New Haven, Connecticut, in January 1878 . By March 1880, there were 138 exchanges in operation in the United States, with 30,000 subscribers. By 1887, a decade after the introduction of the telephone, there were 743 main and 444 branch exchanges connecting over 150,000 subscribers.

The earliest exchanges were crossbar switchboards, consisting of a grid of crisscrossing metal strips. Each subscriber was assigned to a vertical bar. A series of horizontal bars ran perpendicular to these bars and, when a call came in, an operator would use plugs to connect the calling and called parties' vertical bars with the same horizontal bar. As more people subscribed, a multiple switchboard system using several operators allowed each operator to connect any of the hundred or so subscribers for whom that operator was responsible to the operator handling the party being called. But the growing number of subscribers in larger cities soon made even this system unwieldy.

The ultimate answer to the problem was automatic switching, with the customer dialing in the desired number instead of the operator. The first automatic exchange was invented in 1889 by Almon B. Strowger, a Kansas City undertaker who believed that the local operator, the wife of a rival undertaker, was diverting Strowger's business calls to her husband. The first automatic switchboard was installed in La Porte, Indiana, in 1892. Initially, some customers objected to automatic switching, contending that they shouldn't have to do the telephone company's job, and it wasn't until the 1930's that automatic switching became widespread.

The invention of the transistor by Bell Laboratories shortly after World War II led to the development of electronic switching systems (ESS) in the 1960's. The new ESS central offices provided greater reliability and a wide range of customer services. The first ESS office was established in 1965. It was followed by the first computerized ESS office in 1976. The new, computerized switching systems could handle 500,000 calls per hour and greatly enhanced the customer services available, such as toll-free 800 numbers, custom calling features and sophisticated call routing. By 1982, half of all calls were switched electronically.

The 1960's also saw the beginning of digital transmissions. Although initial growth in digital technology was slow, by the 1980's it began to come into its own. Digital technology greatly increased the speed and accuracy at which data could be transmitted, a function that was becoming a necessity for the telephone switches of the 1980's.

Present and Future

The 1984 divestiture of the Bell System opened the telephone industry to competition from outside companies. This new openness, plus the advent of advanced technologies, had a profound effect on the way central offices did business. Using fiber-optic cables and broadband switching, competitive access providers (CAPs) began bypassing the local telephone company central offices. At first, they offered private-line, fiber-based backup circuits for long-distance access by large businesses. But as CAPs became more successful, they pushed for the opportunity to offer true switched services to their customers by linking up with Bell central offices. In the past few years CAPs have won a number of major battles that require the local Bell companies to allow the CAPs access to the Bell local customers through the central office equipment.

Meanwhile, the growth in wireless and microcell technology has created a new form of central office bypass: the wireless local loop. Although wireless cellular telephones have been around for some time now, they always eventually tied back into the public switched telephone network. But the new wireless local loop technology allows companies to build microcellular, personal communications networks (PCNs) that would bypass the traditional wireline network. The Federal Communications Commission (FCC) has granted many experimental PCN licenses and has held auctions for available radio frequencies over which the PCNs could operate.

AT&T's divestiture in 1984 also marked a turning point for some other emerging technologies. Large local exchange companies were becoming increasingly frustrated with the time required to roll out new services. These new services usually had to be tied to a scheduled software update of the central office switch, which was sometimes years away. A solution to this problem was the Advanced Intelligent Network (AIN), which premiered in 1989 and finally began operation in 1994. AIN is still evolving, but basically, it allows the network to determine the routing of calls based on network needs at that moment.

The central office switch of the 1990's must be able to handle more than standard voice communications. Computer data and video communications require much greater bandwidth and a fundamentally different type of switching than voice communications. The local telephone companies, with their embedded networks and central office switches, cannot afford to replace everything overnight. But some change is required if

they want to remain competitive with the bypassers and the cable television companies, who see voice signals as a natural addition to their services. Some of the strategies currently being investigated by local telephone service providers are:
1) overlaying high-speed data networks on the existing network where there is market demand, then rebuilding the network from there as the demand grows;
2) replacing the existing network with an integrated services digital network (ISDN), which makes all transmission circuits end-to-end digital and brings significantly more bandwidth to the network; and
3) introducing asynchronous transfer mode (ATM) technology, which provides higher transmission speeds than traditional switching methods and allocates bandwidth on demand.

It currently appears that today's digital central offices will continue to handle voice traffic much as they do now but with the addition of separate adjunct data networks. Eventually, the voice and data networks will be integrated, and the central office of the future will consist of a network of high-capacity lines carrying vast quantities of voice, data and video traffic.

u contributed by Linda Stranahan

Central Processing Unit (CPU)

The central processing unit controls and coordinates all the functions of a computer. Essentially, it is the computer's brain. It consists of an arithmetic/logic unit (ALU) to process data and instructions, a control unit to coordinate the flow of incoming and outgoing instructions and data, storage space to hold data waiting to be processed, and a bus that allows the separate parts to communicate with each other.

The definition of a central processing unit tends to vary. For smaller computers, such as personal computers, the CPU is contained on one silicon chip called a microprocessor. The CPU for larger computers, such as an IBM mainframe, may consist of several circuit boards.

Additionally, when discussing smaller computers, CPU sometimes refers exclusively to the microprocessor chip, which contains the control unit, the ALU, the internal bus, and the storage registers. Other times it refers to both the microprocessor and to the primary storage chip, called Random Access Memory (RAM). For our purposes, this article will focus on the first four components of a microprocessor's CPU: the control unit, the arithmetic/logic unit, the bus, and the registers.

The Control Unit
The control unit is the part of the microprocessor that regulates the flow of data in and out of the microprocessor. The control unit accepts data from primary storage locations, decides what it means, and passes the information along to the ALU via the bus and storage registers.

The Arithmetic/Logic Unit
The ALU is the part of the microprocessor that does that problem solving and "number crunching." Using Boolean logic, a system of algebra that deals with a binary number system, the ALU can perform logical operations by comparing values and making judgments using statements such as IF, AND, and OR. The ALU is capable of performing all four basic arithmetic calculations (addition, subtraction, multiplication, and division), but always does so through addition. For instance, to subtract numbers, the ALU adds negative numbers (10-3=10+[-3]=7); to multiply, it adds numbers one after another (2 X 3 = 2 + 2 + 2=6); and to divide, it repeats negative addition until the sum equals zero and then counts the number of tries it took to reach that point (the ALU sees 8÷4 this way: {8 + [-4]}+-4 = 0, so 2 = number of tries to reach zero). After the ALU has performed the operation, the data is sent back into primary storage.

Though this seems like rather a long route, it takes place millions of times per second. For example, an Intel 80486 microprocessor chip running at 66 MHz (or 66 million cycles per second) can execute 54 million instructions per second. However, other aspects of CPU architecture affect how many instructions per second a CPU can execute. These variables include how much information the CPU processes at one time (word-length) and the width of the computer's data pathway (the bus).

Bus

A computer's bus, like the variety humans use, is a transportation system. Instead of transporting people, it moves data. It is actually a path of circuitry that links two or more points, such as primary storage to the control unit. A bus may link the CPU to different computer components or, through an internal bus, link the different parts of the CPU together. This is how data and instructions move from the control unit to registers to the ALU.

The Registers

The registers serve as an on-deck circle for information that passes from the control unit to the ALU. This helps the microprocessor keep track of the numbers, data, or instructions that the CPU processes. A CPU has various types of registers. An instruction register stores program instructions, which tell the ALU what steps it should perform next. The address register contains information that tells the ALU where to obtain the next piece of data it needs. A storage register (sometimes called a data register) holds information sent from primary storage to the CPU or from CPU to primary storage. The fourth type of register is called an accumulator. Its job is to temporarily store the results of an operation completed by the CPU. The division of labor among the various types of registers allows the ALU and the control unit to work more efficiently.

Coprocessors

Although a microprocessor is able to execute a vast number of calculations every second, sometimes it just isn't enough power. Computer programs that require serious "number crunching," like ones that perform scientific calculations or work with a lot of graphics (such as computer aided design drawings or highly realistic games), benefit from a math coprocessor. This is a specialized chip that works in conjunction with the main microprocessor and handles these specialized functions.

RISC Chips

Computer engineers are always looking for ways to speed up the CPU. One way to do this is to ease the CPU's burden. A Reduced Instruction Set Chip (RISC) eliminates many of the instructions that conventional chips, called Complex Instruction Set Chips (CISC), can perform but rarely do. The PowerPC chip, a microprocessor jointly developed by IBM, Apple Computer, and Motorola, uses RISC technology.

u contributed by Christopher LaMorte

Cerf, Vinton G. (1943 –)

American businessman and entrepreneur, currently employed by MCI Communications Corporation (MCI) as Senior Vice President for Data Architecture, a division of MCI Business Markets. Cerf is often referred to as the "Father of the Internet."

Vinton Cerf suffered a hearing impairment at birth that left him unable to easily recognize voices on the telephone. Quite possibly this handicap is responsible for bringing computer communication to the entire world. Cerf graduated from Stanford University with a BS in mathematics. He also received an MS and Ph.D. in computer science from the University of California at Los Angeles (UCLA).

The Internet, which Cerf helped develop, is actually a group of independent computer networks that have been designed to interoperate, which is simply "speaking" in the same way in order to communicate with one another. In 1982, under Cerf's suggestion, two computer networks utilized a common protocol so users could share information and send memos called electronic mail (E-mail) between networks, and thus the Internet was launched into the world of real-use possibilities. However, the roots of the Internet go back much further.

For years the two obstacles to various computer-to-computer communications were: 1) a way to send information if a direct link was broken; and 2) a common way of talking. In the late 1960's the United States government formed the Advanced Research Projects Agency (ARPA) under the Department of Defense and charged it with the responsibility to discover or develop a way for the various new computers that were located in research centers, large businesses and colleges to share information. The technology that resulted from ARPA's initial efforts addressed the direct link issue. It provided a way for information to be "addressed" and then recognized and routed to the correct place. Continuous communication was of utmost importance during the Cold War environment at the time. The very real fear of a nuclear attack, and what it would do to communications, provided the impetus for the "addressing" technology. In fact, if there was a disaster like a nuclear attack, the computers and research centers were less vulnerable if separate. So, because the communication needs were addressed, distance was not a hindrance to ARPA's research.

In fact, due to ARPA's involvement, in 1969 the first computer network that could send information on a variety of paths was developed and in place. The initial application consisted of four universities' computers hooked up or linked to each other. UCLA, where Cerf was instrumental in its implementation, was one of the universities "on-line." ARPA's network grew, and by 1972, 40 different sites were hooked into what was called the ARPANET.

As more computers hooked onto the ARPANET, the lack of a nation-wide common communication protocol became a larger obstacle. In 1972 Cerf was named the first Chairman of the InterNetwork Working Group, the organization that was responsible for producing a working protocol so that all computers, regardless of their size or intelligence or location, could be connected to a system and share information. In the mid-1970's

ARPA was renamed the Defense Advanced Research Projects Agency (DARPA), and Cerf's group began a project called the Internetting Project to study linking computers to share their vast and growing resources. From here on out, the word Internet became part of the computer-age language.

Regardless of how consumer-oriented the Internet seems today, at the time of development, military and government agencies were the primary focus of its development and use. In 1974 two basic protocols, or sets of rules, were developed by Cerf and Robert Kahn. Called Transmission Control Protocol and Internet Protocol (TCP/IP), the rules provided clear parameters for the way information is sent on the Internet. These protocols allowed various computers to understand and read one another's files and commands. Cerf then took on the daunting task of convincing other computer scientists to use the TCP/IP.

By 1976, while Cerf was at DARPA, the protocols were in place and in use. The next and final step that allowed the Internet to be so widely available today came directly from DARPA and was a surprise. Stunningly, DARPA released the Internet "recipe," TCP/IP, to everyone. Twenty years later, Cerf told a reporter that he supported the commercialization of the Internet from the beginning. He logically saw that the only way it would be of complete value was for everyone to have access through various businesses and industries. So the methods of communication that had been developed for official use in the event of war became available, for free, to any manufacturer, any telecommunications supplier, any country. The next few years saw many manufacturers working on ways to make computers smaller, more effective and more affordable. And while most of these companies worked independently, they all had access to networking information that would allow for subsequent use by virtually every business, industry and individual.

In 1982, Cerf suggested that ARPANET and CSnet (the new Computer Science Research Network developed by DARPA and the National Science Foundation) network their computers. CSnet was to host smaller, independent networks and provide a path to the main ARPANET. When this connection was made using the TCP/IP protocols, today's practical use of the Internet was born.

Cerf moved to MCI in 1982. He was Vice President of MCI Digital Information Services and was mainly responsible for the team that developed MCI Mail, a large provider of E-mail services, today's result of ARPA's "addressing" technology. In 1986 Cerf and fellow-inventor Robert Kahn founded the Corporation for National Research Initiatives (CNRI). While at CNRI, a non-profit organization, Cerf's team conducted even more in-depth research and experimentation in the information technology industry.

After eight years with CNRI, Cerf went back to MCI and, in his current position, he continues to develop tools to effectively move information. As technology changed, MCI went from a telephone long-distance provider to a total information transport provider; Cerf is responsible for the MCI network services that will offer data, information, voice and video services for small- and medium-sized businesses as well as individual consumers.

MCI isn't the only company that moved into the all-encompassing arena of information services, but was one of the first. Starting in 1994, MCI introduced new products, such as networkMCI, internetMCI and marketplaceMCI, as part of the company's new total-information processing plans.

By the spring of 1995, MCI was the carrier for 40 percent of the United States Internet traffic. The Internet itself has grown to 42,000 networks and 30 million users. Vinton Cerf stated that he thinks the current technology, the TCP/IP, can continue to manage Internet traffic and that it is possible to imagine an astounding 600 million networks in the future. Indeed, it is a testament to Cerf's and Kahn's ingenuity that their protocols have not only survived but also continue to serve the industry even after so many years and technical developments.

On any given day, countless individuals access the Internet. A world of information, resources and other individuals is available at the touch of the keyboard. A most common practice is to quickly glance at a multitude of topics, sources and groups. Users often refer to this as "surfing the Internet." Little do they know that "Cerf-ing the Internet" is far more accurate.

u contributed by Michele Messenger

Comcast Corporation

One of the nation's ten largest multiple system cable television operating companies (MSOs), Comcast Corporation also owns controlling interest in QVC Inc., the highly successful cable home shopping network, and is a partner in a new national wireless communications venture. Based in Philadelphia, Pennsylvania, Comcast Corporation was founded in 1963 by Ralph J. Roberts, and is currently under the leadership of CEO Brian L. Roberts.

Ralph Roberts, founder of Comcast Corporation, worked at the Pioneer Suspender Company in Philadelphia from 1950 to 1961. In 1961, he realized that it was time to leave the company for greener pastures. He sold the company, now known as Pioneer Industries, Inc., and started an investment venture capital company called International Equity Corporation (IEC).

Two years later, in 1963, Daniel Aaron, a former executive for Jerrold Electronics, secured a contract to sell a small cable television system in Tupelo, Mississippi. Aaron contacted Roberts, who agreed to buy the cable system if Aaron would join him in running the business. Aaron agreed. Also joining Roberts in this venture was his accountant, Julian Brodsky, now company Vice Chairman, whose financial expertise on behalf of Comcast is renowned. From this meager start, Ralph Roberts and, in later years, his son, Brian, have built one of the largest cable television operating companies in the United States.

In the years that followed the Tupelo purchase, Ralph Roberts led Comcast Corporation through a number of cable system purchases. More recently, the most significant of these included a joint purchase of the Group W Cable systems in the mid-1980's, and the acquisition of Storer Communications's cable systems in 1988. In 1993, the company acquired the Maclean Hunter Ltd. cable systems, which added nearly one-half million households to Comcast's subscriber base.

Brian L. Roberts, son of the founder, is current President and Chief Executive Officer (CEO) of Comcast Corporation. One of the youngest CEOs of a major corporation, Brian was appointed to his current position when he was 30 years old. Like his father, Brian attended the University of Pennsylvania's Wharton School. During summer vacations from college, he helped install cable to the homes of new Comcast cable subscribers. He graduated from Wharton in 1981 and joined Comcast to work first as Assistant Manager for a smaller system in Trenton, New Jersey, then for a larger system in Flint, Michigan. Following his field training, Brian joined the management team at corporate headquarters in Philadelphia in 1985. Since that time, Comcast has also diversified into several other areas of telecommunications services.

It was founder Ralph Roberts, long-time fan and supporter of Joseph Segel and his successful Franklin Mint, who encouraged Segel to start QVC, the highly successful cable shopping channel. When Segel decided to leave QVC in 1992, Comcast CEO Brian Roberts launched an all-out effort to have former Fox Network Chairman Barry Diller fill the position of Chairman at QVC. So, Diller was named Chairman and, in fact, invested

$25 million of his own money, becoming the primary owner. In the change of leadership, Comcast Corporation acquired 15 percent ownership of QVC.

Then, in 1994, Comcast Corporation entered into a joint venture with Liberty Media, a wholly owned subsidiary of Tele-Communications, Inc. (TCI), to acquire QVC. The transaction became final in August 1994, and Comcast now owns 57 percent controlling interest in QVC, with Liberty Media owning 43 percent. Management responsibilities for QVC are handled by Comcast, and, to date, Barry Diller remains in his position as Chairman, even though the Comcast purchase thwarted his attempts to merge QVC with the Columbia Broadcasting System (CBS). A recent QVC bid, which was backed by Comcast, to take over ownership of Paramount Communications, was unsuccessful. However, Comcast is continuing its quest to find other partners for future programming opportunities. The company currently owns interest in several cable programming services in addition to QVC. These include E! Entertainment; the Turner Broadcasting System Inc. (TBS); Viewers Choice, which offers pay-per-view movies and special events; and Music Choice, a CD-quality music programming service.

Comcast has acquired significant holdings in other areas of telecommunications as well. In 1988, Comcast became a major investor in Amcell, a little-known cellular telephone company based in New Jersey. In 1992, it acquired all of John Kluge’s Metrophone cellular telephone business, which substantially increased the company’s penetration in the greater Philadelphia area. Today, Comcast’s Metrophone/Cellular One business is the leading cellular telephone service in the northeast area of the country. In an area with a population of more than 7.4 million, Comcast Cellular is the major provider of cellular service from northern New Jersey to southern Delaware. Its cellular telephone business continues to grow at an average of 40 percent each year.

Comcast is also a 17 percent owner of Nextel Communications, Inc., a national wireless communications company which is based in Rutherford, New Jersey. Originally named Fleet Call, this organization owned the rights to a significant amount of wireless transmission spectrum, or bandwidth. At the urging of Brian Roberts, MCI Communications Corporation is also a 17 percent owner of Nextel. News of MCI’s investment in Nextel, when it was announced in 1994, caused the value of Comcast Corporation stock to quintuple in value. Other technology partners in the Nextel venture include Motorola, Northern Telecom, Nippon Telephone and Telegraph and Matsushita. In 1994, Nextel launched its national digital cellular voice and data service in Los Angeles.

Comcast Corporation is also involved in traditional wired telephone services in both the United Kingdom and the United States. The company owns controlling interest in Eastern TeleLogic Corporation, an alternate access provider headquartered in Philadelphia as well. In addition, it has secured a 20 percent ownership interest in Teleport Communications Group, also an alternate access provider of long-distance services.

The father-and-son team leading Comcast Corporation is unique in the telecommunications industry. Brian is one of five children in the Ralph Roberts family, and was the only child who expressed a strong interest to work in the family business. As part of Comcast’s management team since 1985, Brian has learned the intricacies of the business from his father, who is also his mentor. Both Ralph Roberts and Brian Roberts are highly respected in the telecommunications industry. They are known for the complete trust they have in each other and for the very savvy transactions they have negotiated on behalf of Comcast.

In 1994, Comcast Corporation had 3.4 million cable subscribers in more than 500 communities and revenues well in excess of $1.2 billion.

u contributed by Valerie Switzer

Roberts, Brian L. (1959 –)

Appointed President and Chief Executive Officer of Comcast Corporation at the age of 30, Brian L. Roberts is one of the youngest corporate leaders in the telecommunications industry today. He heads one of the ten largest cable television companies in the United States. Roberts is perhaps best known for his ability to spot an ideal opportunity and "zero in" to aggressively pursue a new acquisition and negotiate a very favorable agreement. He led Comcast in the 1994 corporate takeover of QVC Inc., the successful cable home shopping network.

Brian L. Roberts was born in 1959, four years before his father, Ralph Roberts, bought his first cable television system in Tupelo, Mississippi. One of five children in the Ralph Roberts family, Brian, like his father, was a graduate of the University of Pennsylvania's Wharton School. During summer vacations from college, Brian helped string cable to the homes of new Comcast cable subscribers. Following graduation in 1981, he started working full time at Comcast Corporation. His initial assignments included time spent as an assistant manager of the company's cable system in Trenton, New Jersey, and later in the same position for a larger cable system in Flint, Michigan.

When he permanently joined the management team at corporate headquarters, he was on hand to help plan a series of savvy corporate moves. In 1985, Comcast submitted an offer to buy the cable division of Storer Communications. Although the offer was not accepted, it proved to be the catalyst in positioning Comcast for other opportunities. Soon after, the company was asked to participate with a group of investors joining together to buy the Group W Cable systems. In 1988, Comcast got a second opportunity to buy Storer and partnered with Tele-Communications, Inc. (TCI) in submitting a $l.5 million bid and clinching the deal.

In the same year, Comcast also became a major investor in a New Jersey-based cellular telephone company, Amcell. In 1992, the company acquired all of the Metrophone cellular telephone properties. This purchase gave Comcast additional cellular holdings in the greater Philadelphia area. Today, Comcast has a strong cellular telephone customer base in the northeast portion of the country. Its cellular operation is growing by approximately 40 percent annually.

Both Brian and his father, Ralph, founder of Comcast, are highly regarded in the industry for not only their strong personal working relationship, but also their ability to negotiate very smart transactions. In the *Los Angeles Times* in April 1994, noted TV figure Barry Diller said about Brian, "He and his father have one of the great things going…they have complete trust."

Brian's father, Ralph, is a long-time admirer and supporter of Joseph Segel, founder of the Franklin Mint, a successful venture that sells upscale collectibles. It was Ralph who encouraged Segel to start QVC Inc., the highly successful cable home shopping channel. Comcast invested cash in the endeavor, and Ralph Roberts made numerous calls to other cable industry leaders encouraging them to carry QVC on their cable systems.

In 1992, when Segel chose to leave QVC, Brian Roberts spearheaded an effort to secure Barry Diller, former Fox Network Chairman, as the new Chairman of QVC, who would have then become a partner with Comcast Corporation in a management vote. While it didn't work out exactly as planned, Barry Diller was named Chairman and became the major owner at that time, investing more than $25 million of his own money. Comcast acquired 15 percent ownership of QVC.

Then, in a surprising move in mid-1994, Brian Roberts submitted an offer from Comcast to buy QVC in partnership with Liberty Media, a move which foiled Barry Diller's planned efforts to merge QVC with the Columbia Broadcasting System, Inc. (CBS). Comcast now controls 57 percent of QVC, and partner Liberty Media controls 43 percent. Not a bad day's work for Roberts, as QVC reported $1.2 billion in revenues in 1993, with cash flow growth of approximately 15 percent annually. Prior to the takeover, Diller had announced plans for two new shopping services, Q2 and OnQ, intended to appeal to younger, more affluent audiences. At the time of Comcast's purchase of QVC, Roberts announced that the plans developed by Diller would remain intact.

It was also Brian Roberts who contacted the Newhouse family's vast Advance Publications, Inc., to ask for a $500 million commitment toward a possible purchase of Paramount Communications in QVC's recent unsuccessful takeover bid of Paramount.

In other transactions, Comcast invested $70 million in 1992 in Fleet Call, a two-way radio dispatch service based in New Jersey. Fleet Call owns the rights to a sizable amount of wireless radio spectrum, or bandwidth, which is also known as Specialized Mobile Radio (SMR). Now known as Nextel Communications, Inc., the company began its national roll-out of digital cellular voice and data service in 1994 in the Los Angeles market. In the same year, Brian influenced Comcast to invest in Nextel Communications's new national wireless network. In another aggressive move in 1994, Brian recruited MCI Communications as an equal partner in the Nextel venture. The news of this new partnership caused the value of Comcast Corporation stock to quintuple nearly overnight. This agreement gave both Comcast and MCI approximately 17 percent interest each in Nextel. Technology partners in this venture include Motorola, Northern Telecom, Nippon Telephone and Telegraph, and Matsushita.

Comcast Corporation is also involved in traditional wired telephone services in both the United Kingdom and the United States. The company owns controlling interest in Eastern TeleLogic Corporation, an alternate access provider headquartered in Philadelphia. In addition, it has secured a 20 percent ownership interest in Teleport Communications Group. Other partners in this venture include Sprint Corporation, Tele-Communications, Inc. (TCI), and Cox Communications, Inc.

A frequent flyer, Brian spends much of his time on the company's corporate jet flying to and from the United Kingdom, where Comcast currently owns three cable television and telephone systems. He is also a regular visitor to Washington, D.C., where he has emerged as an enlightened industry leader who is helping to shape current telecommunications policy. According to many sources, he understands the political process and is willing to get involved.

Currently, Comcast Corporation has more than 3.4 million cable subscribers throughout the United States. With that, Comcast is one of the largest MSOs in the country with controlling interest in the nation's largest cable home shopping network and a new wireless communications division. With these new diversified services, it seems that Brian Roberts will be as busy as ever. However, through the legacy of knowledge and experience passed onto him by his father, Brian may be one of the most qualified of the new generation of leaders in the telecommunications industry today.

Roberts is a member of the Board of Directors of Comcast Corporation, the Turner Broadcasting System, Inc. (TBS), QVC Inc., Viewers Choice, and The Golf Channel. In addition, he is a member of the Board of Directors of Comcast UK Cable Partners Limited, Cablevision Investment of Detroit, Inc., and Storer Communications, Inc. He is also a member of the Board of Directors for Cable Television Laboratories (CableLabs), the research and development organization exploring technological advancement for the cable television industry, based near Boulder, Colorado.

Brian Roberts and his wife, Aileen, and their three children live in the northwestern section of Philadelphia.

u contributed by Valerie Switzer

Communication Satellites: History and Development

Satellite communications began simply in 1954, when radio waves were sent between Washington, D.C. and Hawaii by bouncing them off a satellite made of rock — the Moon. This system of satellite communication using a natural satellite was used successfully from 1959 to 1963. But the world changed dramatically on October 4, 1957, when a small, artificial satellite named Sputnik (Russian for "Fellow Traveler") arched across the sky at 17,000 miles per hour. Although not a communication satellite, Sputnik's faint beeping announced a new era of human interaction through global communication.

History

Until 1956, when the first transatlantic telephone cable (TAT1) began carrying telephone calls under the ocean between Newfoundland and Scotland, the only two ways to communicate across the ocean were via the transatlantic telegraph cable or short-wave radio. As Sputnik was in the process of making its 1,400 orbits around the earth, the U.S. Air Force was preparing to launch the world's first active satellite, called satellite communication by orbiting relay equipment (SCORE). This rudimentary communication satellite, launched in December 1958, was not much more than a very remote answering machine that recorded voices as it passed over an earth station, then played them back as it passed over a second earth station. The 1958 Christmas greeting from U.S. President Dwight D. Eisenhower was the first voice communication to be transmitted by an artificial satellite. During its 12 days in orbit, SCORE proved that satellite communications were possible.

In August 1960, the United States launched Echo I, a 100-foot diameter Mylar balloon that reflected signals off its metallic surface, just as the Moon had. Echo I functioned for eight years. Despite the success of Echo I, scientists already knew that passive satellites were not quite good enough. Even before Echo I was launched, technological advancements were pointing the way to active satellites that could receive, amplify and retransmit signals to specific locations on Earth, not just reflect them in random directions.

In 1959, four technological advancements paved the way for the communication satellites of the future. First were improvements in microwave antennas for both transmitting and receiving signals. Second was the development of broadband transistors that allowed the electronics in a satellite to be miniaturized. Third was special high-frequency transistors, which enabled the use of high-frequency radio waves that could penetrate the ionosphere. And the fourth advancement was the development of microwave amplification by stimulated emission of radiation (MASER), which amplified the microwaves but did not add a great deal of electronic noise.

In 1960, following the successful launch of Echo I, the U.S. Department of Defense put the first fully active satellite into orbit. Called Courier, it was also the first communication satellite to use solar (photovoltaic) cells to convert sunlight into electricity to power the on-board electronics.

In December 1960, outgoing U.S. President Eisenhower set a national objective of creating a commercial satellite system; however, it was up to the incoming President, John F. Kennedy, to carry out the dream.

Just four months after taking office, President Kennedy was faced with yet another challenge from the Russian space program. On April 12, Russian cosmonaut Yuri Gagarin became the first human in space when he made one Earth orbit in his spacecraft named Vostok. This, combined with the embarrassment of Sputnik's success, may have been what caused President Kennedy to increase the budget of the National Aeronautics and Space Administration (NASA) by $50 million in an effort to bolster the reputation of the United States.

In a speech on July 24, 1961, President Kennedy invited "all nations to participate in a communication satellite system, in the interest of world peace and a close brotherhood among peoples throughout the world." What Kennedy had done was to take the space program out of the stuffy world of science and make it part of U.S. foreign policy. Everyone likes a winner, but in 1961 the vaunted space program of the United States was following the USSR across the finish line. President Kennedy could only talk about high ideals and hold out the possibility of success in an attempt to ensure the loyalty of America's allies. But the United States had to prove to the world that its space program would work; it needed a success.

In July 1962, the United States achieved this success. Telstar, the first truly interactive satellite, was launched. Telstar was also the first privately funded satellite, having been designed and built by American Telephone & Telegraph (AT&T). In addition, AT&T had to reimburse NASA for the use of its launch facilities, the launch vehicle, and the launching and tracking of Telstar. During each of its two hour and forty-minute orbits, Telstar was in contact for ten minutes with two earth stations, one in the United States and one in Europe. Telstar became the first satellite to transmit live television and phone signals between the United States and Europe. Eventually it provided communication between the United States, Great Britain, France, Brazil and Italy.

In December 1962, President Kennedy signed the Communications Satellite Act to create the Communication Satellite Corporation (COMSAT), a private company that would be half owned by the carriers, for example AT&T and GTE, and half by stockholders. COMSAT would have a monopoly on the coordination and control of all U.S. international communication satellites.

Clearly, in order for a network of communication satellites to be effective, it would have to be able to transmit and receive messages for more than 10 minutes at a time. One of the ideas being considered was a proposal to ring the earth with a constellation of 24 satellites so a network of earth stations would always have contact with at least one satellite. AT&T proposed a constellation of 50 passive satellites in low-polar orbit, approximately 3,000 miles above the earth. (Although neither of these ideas was implemented, 30 years later the concept of ringing the planet with constellations of satellites would return.) One idea that did create interest was the concept of putting satellites into an orbit 22,300 miles above the equator.

One of the earliest people to present ideas about satellite communications was Arthur C. Clarke, a physicist and Secretary of the British Interplanetary Society . (Dr. Clarke was to later write one of the most famous science fiction novels in history, *2001: A*

Space Odyssey.)

In 1963, the United States began its program to put a communication satellite into geosynchronous orbit. The first attempt was in February 1963, when Syncom was launched; however, its electrical system failed and it did not achieve geosynchronous orbit. In July 1963, Syncom II did achieve near-geosynchronous orbit.

By 1963, the expansion of global communications was creating a problem. The radio frequency spectrum used for communications between the earth and satellites needed to be controlled so that interference didn't disrupt signals. The International Telecommunications Union (ITU), an agency of the United Nations that regulates radio frequencies used for international communications, allocated 2,800 MHz for space communications. When fully utilized, this bandwidth would be capable of carrying 8,000 to 9,000 telephone calls, a capacity that was thought to be ample when compared with the 550 transoceanic telephone circuits that were available in 1961.

In 1964, a busy period in United States satellite communications began. Echo II was launched, enabling Russian and American scientists to communicate with each other. Relay I, built by RCA, was the first satellite with redundant systems that could be used if a primary system failed. Relay II, launched in July 1964, used a traveling wave tube to amplify the microwave signals as much as one million times with very little noise, or signal interference. A traveling wave tube amplifier is a vacuum tube that slows down the signal, which is an electromagnetic wave traveling at the speed of light, then uses electrons to amplify the signal before it is retransmitted. As late as 1995, traveling wave tubes were the only vacuum tube still used on communication satellites, all others having been replaced by solid-state components.

In August 1964, Syncom III became the first U.S. satellite to achieve geosynchronous orbit. With Syncom III, the world immediately saw the benefits of having a geostationary communication satellite. It allowed television networks to broadcast live from the Tokyo Olympics and make the transmission available to one-third of the world. All U.S. communication satellites following Syncom III were put into geosynchronous orbit.

Although geosynchronous orbit is the most desirable, since it remains over a given area, it does not allow communications with areas near the north or south poles. Because a significant portion of the USSR was above the Arctic Circle and not within the footprint or area covered by a satellite in a geostationary orbit, the USSR put many of its communication satellites into an elliptical orbit called a Molniya orbit. This orbit cannot be geosynchronous, since it does not lie above the Equator.

Efforts to build the first international satellite communications system were begun in 1964. The International Telecommunications Satellite Organization (INTELSAT) was formed in August with 11 member nations. COMSAT became the U.S. signatory (representative) to this international body and was the initial manager of the INTELSAT system. In April 1965, INTELSAT's first satellite, Early Bird (later called INTELSAT I), was launched, and in June it began service . Early Bird was a 150 pound (68 kilogram) satellite with two transponders, which are signal repeaters. Each transponder had a 30 MHz bandwidth. Early Bird's transmitting power was 4 watts and its 6,000 solar cells could generate 45 watts of power for the on-board electronics. It had a total of 240 circuits for telephone communications. At the time, the largest transoceanic cable had 256 circuits. Starting in 1965, and continuing until 1980, the expansion in the capacity of satellites to carry more communications resulted from using a greater portion of the available 500 MHz bandwidth.

The first decade of satellite communications saw growth in large increments. Many lessons were learned from the numerous launches of satellites, as well as from the manned-flight space programs of the United States and USSR, which were challenging each other for space supremacy. Satellite communications were also enabling better communications between astronauts and their ground controllers.

In 1975, a significant event occurred that would trigger the rapid growth of one communication industry and have a tremendous impact on the development of communication satellites. Home Box Office (HBO) began distributing movies to cable television (CATV) systems via Satcom I. Movies gave the cable television industry something that viewers would pay to receive and provided the impetus for incredible growth in the number of cable customers. HBO’s popularity, followed by the success of Showtime and Cinemax, two other movie channels that were also delivered to cable operators by satellite, began to move the CATV industry into the position of being the single largest user of communication satellites.

From 1980 to 1992, the communication satellite industry was able to expand its capacity to transmit signals by utilizing digital technology. Channel reuse, a method in which a single satellite could use the same signal frequency for different communications to different locations, was like splitting each channel into six. Time division multiple access, which allowed each frequency to carry multiple signals, created its own efficiencies, as did digital compression. The expanded capacity of satellites is epitomized by a comparison of INTELSAT VII, the seventh generation of international communication satellites, to INTELSAT I. INTELSAT VII satellites have a capacity of more than 100,000 circuits; INTELSAT I had 240 circuits.

In 1993, 11 new commercial communication satellites were launched; in 1994 there were 23 new commercial satellites launched. Today, there are 78 space centers in 22 countries, and governments or companies in 46 countries own the hundreds of commercial and government-owned communication satellites that are in orbit.

Satellite Technology

Early communication satellite technology was amazing to most people, not just because a signal could be bounced off of something hundreds of miles from Earth, but because a satellite could even be put into orbit. In 1958, when a tape recorder was sent into orbit in the satellite SCORE, it was the peak of high technology. For many people who had grown up riding in buggies, hearing President Eisenhower’s 1958 Christmas greeting coming from space was beyond imagination.

Today, hundreds of communication satellites are launched each year, most without any mention in the press. The United States uses the Space Transportation System (STS), most commonly known as the Space Shuttle, to launch satellites into low-earth orbit (LEO), where they are then boosted into geosynchronous orbit  . The Space Shuttle is capable of putting up to 33 tons of payload into a LEO. The nearly impossible of yesterday has today become commonplace.

Since Syncom III, all U.S. communication satellites have gone into geosynchronous orbit over the Atlantic, Pacific or Indian Oceans. Satellites are bought and sold while in orbit, then moved by the new owner to a new location, just as a parking lot attendant maneuvers cars around. Satellite systems, called constellations, include not only the satellites in orbit and in use, but spares that are parked in orbit waiting to be activated.

Communication satellites are comprised of two major systems, the spacecraft bus and the communications payload. In addition to the structure of the spacecraft, the bus includes the electrical power subsystem, which generates electricity and stores it in nickel-hydrogen batteries; the propulsion subsystem, which uses hydrazine as a propellant to periodically adjust the satellite's position or change its orbit; the thermal control subsystem, which protects the electronics from the extreme ranges of heat and cold; and the telemetry, tracking and control (TTC) subsystem, which the ground stations use to control the satellite.

The communications payload is primarily composed of the transponders and amplifiers, which receive signals, change their frequency, amplify them and retransmit them to Earth.

Communication satellites have a launch weight that ranges from 1,100 pounds to 4,400 pounds (500 to 2,000 kilograms). Their diameters range from approximately 5 feet to 11 feet (150 to 360 centimeters) and they vary in height from 6.5 feet to almost 40 feet (200 to 1,200 centimeters).

Thousands of photovoltaic cells convert sunlight into 400 to 3,000 watts of electrical power. Transmitting power, one of the most significant factors in the size of the receiving antenna on Earth, can be as low as 2 to 50 watts for large, fixed antenna sites; 30 to 100 watts for maritime communications; and 50 to 200 watts for direct broadcast satellite (DBS) service. In 1990, satellite experts felt that transmitting television pictures directly to small antennas on viewer's homes was unrealistic, because communication satellites were not capable of generating a transmitting power great enough to deliver a usable signal to the two-foot diameter antennas that DBS companies were proposing. However, in just four years, satellite technology improved to the point that in 1994 three DBS companies began transmitting digital pictures and sound directly to home antennas.

Communication satellites have antenna arrays that enable them to receive and transmit radio frequencies ranging from 390 MHz to 100 gigahertz (GHz). Although these high frequencies are necessary to penetrate the ionosphere, they are more susceptible to signal loss and rain interference than low frequencies. Signals are sent from the transmitting antenna at one frequency, typically 6 GHz or 14 GHz, depending upon which portion of the radio frequency spectrum is being used for communications. The signals are then retransmitted by the satellite to the receiving antenna at a lower frequency, typically 4 GHz or 11 GHz. Signals can be focused to cover areas of the earth as small as 231 square miles (600 square kilometers), or they can cover one or more continents.

Antennas

Technological advancements have not been limited to just the satellites. Earth stations, the parabolic shaped antennas that send and/or receive satellite signals, have become smaller and less expensive, enabling developing nations to build and operate national satellite systems that provide telephone service more cheaply than if they constructed a land line telephone network.

A typical communication satellite earth station that transmits (uplinks) and receives (downlinks) includes: the antenna and tracking subsystem to keep the antenna pointed at the correct satellite; the feed system, which transports the signal from the antenna to the user; a high-power amplifier (HPA) and low-noise amplifier (LNA), which boost the signal level so that it is usable; the up converter and down converter, which either convert the signal to a higher frequency for transmission or convert a received frequency to a lower one so it can be used; ground communication equipment (GCE), which includes modems and coders; the control and monitoring equipment (CME), which ensure proper operation of the earth station; and power supplies to provide electrical power to the system.

The diameter of an earth station antenna is related to the power or strength of the signal; weak signals (2 to 50 watts) require large antennas. Originally, the antennas had to be 100 feet in diameter to receive the low-power signals from communication satellites. As satellite electrical systems were improved, they could transmit a strong signal (100 to 200 watts) and focus it on a specific area of the earth, thus allowing smaller antennas to be used.

One growing use of satellite antennas is for satellite master antenna television (SMATV) systems. SMATV is typically used to receive television signals that are then distributed to guests in hotels or residents of apartment buildings or mobile home parks; however, SMATV systems are expanding to compete with cable television systems for customers.

Private Communication Satellite Networks

In 1980, a consortium of COMSAT, IBM and Aetna Insurance, called Satellite Business Systems (SBS), saw that the new communication technology could be used by American businesses for such things as data transmission, telephony and video conferencing. However, American businesses did not rush to sign up: by 1982 only three companies had leased satellite circuits.

Although SBS was slightly ahead of its time and eventually went out of business, other companies decided to pursue the same idea. In March 1983, Orion Atlantic became the first company to apply to the FCC for a license to build, launch and operate its own satellite system. The application created a problem for the FCC and COMSAT, since COMSAT held the monopoly on international satellite communications in the United States. In August of the same year, International Satellite, Inc. also applied for a license to build and operate its own communication satellite. INTELSAT, seeing a need for business communications via satellite, began its International Business Services (IBS) in 1983, offering a full range of digital services that included video conferencing, high- and low-speed data transmission, facsimile transmission, packet switching, non-public switched telephone service and E-mail. Between 1983 and 1988, nine companies applied to the FCC for permission to build, launch and operate their own communication satellite systems; however, years of hearings and meetings would delay the first launch by one of these companies until 1994.

Ten years earlier, in 1984, Hewlett-Packard, having grown frustrated with the slow speed of data transfer using telephone lines and the necessity of shipping data across country by courier, started using two transponders on Telstar II for high-speed data transfer. By 1985 there were 25 companies with leased space on communication satellites. One of those companies was Safeway Stores, Inc., which began using satellite communications for in-store advertising, new product introductions, and employee training. By 1986 the number of companies leasing communication satellite circuits had increased to 99.

With the growing perception that corporate communications could use satellites, support companies jumped into every aspect of the new technology. Holiday Inn joined Videostar, Private Satellite Network and World Port to offer video conferencing services to businesses. Federal Express offered E-mail services via satellite. Computer satellite networks were run by Equatorial Communications, Vitalink and Telenet (Sprint). Equatorial Communications linked 2,500 Farmers Insurance agents to their headquarters and enabled them to perform address changes, check driving records and process claims. Telenet, a subsidiary of Sprint, connected 2,100 K-Mart stores for credit authorizations, inventory control and pricing, energy monitoring and video demonstrations. By 1987, corporate satellite communications was a $567 million business.

One reason for the eventual success of fully-interactive business satellite communication systems was the development of the very small aperture terminal (VSAT). The VSAT antenna is less than 3 feet (1 meter) in diameter. In the United States, there are more than 270 VSAT networks using over 100,000 VSATs, 40 percent of which are used for one-way data transfers, 25 percent for interactive data communications, and 35 percent for broadcast television. Typically, VSATs are used for point-to-multipoint communications. For example, the central office of a business can communicate with multiple branch offices less expensively than it could by using normal telephone land lines. For example, Wal-Mart Stores uses its VSAT network to check each store 12 times a day for inventory control.

VSAT systems are used to deliver background music to office buildings and stores by companies such as Muzak and the Seeburg Satellite Music Network. Safeway Stores, Inc. and K-Mart use satellite-transmitted music in their stores. In 1990, approximately 83 percent of the AM radio stations and 92 percent of the FM radio stations in the United States had satellite antennas that allowed them to receive music and news from central locations or from national radio networks.

Television receive only (TVRO) earth stations became very popular in the United States in the 1980's and by 1995 there were approximately four million in use. TVROs cannot be used to transmit a signal; however, a user can receive hundreds of television channels from a multitude of satellites.

In the mid-1980's, earth stations got smaller and the global village grew closer. Small, portable antennas changed the way news was broadcast in the United States. Satellite news gathering (SNG) became common, and satellite news vehicles (SNV) equipped with small antennas enabled network affiliates to transmit news to the network, not just receive satellite telecasts. The success of Live Aid in 1985, a worldwide charity broadcast carried by INTELSAT, and Sport Aid in 1986, which is the largest television broadcast in history, showed that global television was more than possible — it was already a way to link the people of the planet. Portable earth stations were used by network television to broadcast live pictures of Mexico City following the earthquake on September 20, 1985. Suitcase-sized earth stations are now used when events occur in areas where fixed antennas are not available or when they have been damaged by natural or man-made disasters.

The television industry, both broadcast and cable, has fallen in love with satellite communications. Cable television and broadcast television are the two most common uses for communication satellites, with telephone service and data transmission ranked third and fourth. Experts predict that data will outrank telephony when data transmission rates approach what can be achieved with land lines and when encryption methods ensure the privacy of the data that is transmitted.

Communication Satellites Today and Beyond

The communication satellite industry is global in scope. There are 78 space centers in the world that are used to launch and track the hundreds of satellites that circle overhead. These new communication devices have created changes in the way people communicate with each other and even how they perceive one another.

Until 1986, the industry was dominated by the United States, France and the USSR. Following the 1986 explosion of the Space Shuttle *Challenger* and the failures of a French Ariane rocket and a U.S. Delta rocket in the same year, there was a two-year lull in satellite launchings. The break up of the USSR in 1988 and its reformation into the Commonwealth of Independent States (C.I.S.) also delayed the Soviet program. The delays and associated backlog of launchings caused by the events of 1986 and 1988 allowed the Chinese and Japanese to move into the launch business.

In December 1994, Orion Atlantic, the company that was first in line in 1983 to apply for permission to launch its own satellites, finally launched a $340 million satellite from Cape Canaveral, Florida.

Beginning in 1995 and continuing through 1997, Eutelsat, the European version of COMSAT, will launch a series of Hot Bird satellites that will broadcast digital television signals, making the eventual conversion to high-definition television (HDTV) possible. Also in 1995, an idea originally proposed in the early 1960’s was revived by two companies. Motorola plans to build and launch a network of 66 satellites in a non-geosynchronous low-earth orbit (LEO) . The project, called Iridium, would enable people with portable, cellular-like telephones to make and receive calls from anywhere on the planet. Since the high-power satellites will be only 300 to 500 miles above the earth, the small, lightweight phones can use short antennas. Teledisc, which is a joint venture between William “Bill” Gates of Microsoft and Craig McCaw, former owner of McCaw Cellular Communications, proposed to launch 900 global communication satellites into LEO. In the Teledisc system, approximately 840 of the satellites would be active and the rest would be spares. The satellite system would allow voice, data and video to be transmitted.

Because of communication satellites, the time that separates the voices of any two people on Earth has shrunk to 320 milliseconds, the time it takes for a voice to be transmitted to and from a geostationary communication satellite. If Iridium and Teledisc succeed, that time will be much shorter.

Personal communication links may someday place people in instant contact with the world, but the capability of satellite communications is already affecting everyday life.

By the mid 1990’s, many companies used satellite relay systems, such as Omnitracs, to track the location of trucks, trains and buses. In early 1995, for example, two men who allegedly beat a man in Denver, Colorado, and escaped on a city bus were apprehended when the satellite tracking system enabled police to locate the bus. Some freight companies use small, hand-held transmitters to send delivery information via satellite to a central location so they can keep track of individual packages.

As businesses rely more and more on satellite communications to maintain contact with domestic and international offices, teleports have been built around the United States. These facilities provide access to satellite services and fiber optic networks and can also serve as a communication hub linking together a VSAT network. Teleports are located in many major U.S. cities, including New York, Chicago, Washington D.C., Dallas and San Francisco.

Since the early days of space exploration and communication satellites, when the life of a passive satellite was measured in weeks, advanced technology has enabled highly complex communication satellites to be used for 10 to 14 years. Since the first geosynchronous satellite, Syncom III, one of the major factors determining a satellite’s lifespan has been the propellant used to maintain the satellite’s orbit and position. When the propellant runs out, the small adjustments necessary to keep the satellite in position cannot be made, and eventually the satellite is attracted by the earth’s gravity, causing it to reenter the atmosphere and burn up. To solve this problem, scientists from NASA and the European Satellite Agency (ESA) are examining ways to replenish the propellant used in satellites.

Some of the technologies under development include ion engines, advanced batteries to store electricity, phase-arrayed antennas, solid-state amplifiers that would replace the traveling wave tube, and on-demand power levels to enable signals to penetrate obstructions, such as rain. With the new proposals for dozens of satellites in LEO, technology will be needed to enable satellite-to-satellite linkages. Perhaps one the most ambitious efforts is to install on-board network switching equipment in each satellite, giving them the capability of routing communications to any place or anyone on Earth.

Through such projects as NASA’s Advanced Communications Technology Satellites (ACTS), which were originally launched in 1992; Japan’s COMETS satellites; and ESA’s Artemis project, these and other new technologies are being developed and tested.

Satellite communication has enabled the people of more than 200 countries to communicate with each other as though they lived in the same village, and it appears that soon people will be in touch no matter where they go. Whether people can stand that much closeness remains to be seen.

u contributed by Paul Stranahan

Communication Satellites: How They Work

Communication satellites are spacecrafts that orbit the Earth, receive radio signals from the ground and redistribute them to diverse areas across the planet.

Communicating across long distances presents great challenges. Conventional ground-based methods of transmitting voice, video and data face many practical constraints. For example, radio and television signals are distributed by a series of antennas that relay the signals to their destination. To send radio signals from New York to London in this manner would require building off-shore antenna towers spanning the Atlantic, which is not feasible. And although possible, it takes considerable resources to lay telephone cable under the ocean.

Communication satellites are useful because they can overcome these problems and distribute signals from a point to one or more distant points across much of the Earth. Today, many international telephone calls and all live global television broadcasts, such as the Olympics or the Academy Awards, use satellite transmissions.

Satellite Equipment

The first communication satellite, Echo I, launched in 1960, was nothing more than a plastic balloon coated with shiny aluminum and had few of the advanced capabilities of its successors. An experimental device, Echo I was a passive satellite because it only reflected signals back down to Earth. Two years later, American Telephone and Telegraph (AT&T) launched a more sophisticated satellite, Telstar I. This satellite contained receiving and broadcasting equipment, making it an active satellite. Telstar I transmitted the first live trans-Atlantic television and telephone signals.

Active satellites have since become the standard. Basically, they are radio stations in space. Antennas located on Earth, called earth-station antennas (or satellite dishes), beam microwave radio signals to the satellite. Antennas located on a satellite receive these uplink signals. Transponders on board the satellite are tuned to receive particular frequencies and convert them into different frequencies suitable for re-transmission to receiving earth-station antennas back on the ground. The transponder also amplifies the signal so it is strong enough to be received. The re-transmission of these signals is called a downlink. One transponder can handle about 1,200 one-way telephone calls or one color television channel at a time. A typical communication satellite will carry many transponders, handling about 36,000 two-way telephone calls and 60 color television channels.

Though satellites use the most advanced solid-state components, a special vacuum tube called a traveling-wave tube is used for downlink transmissions. The transistor and integrated circuit, developed in the 1950's, replaced most vacuum tubes. The traveling-wave tube is the last vacuum tube currently used in communication equipment. In time, solid-state components may also replace this vacuum tube. Solid state components, such as microchips, serve a variety of other functions on the satellite. For example, one microchip developed by Western Electric is used to eliminate echoes. An echo is a disturbing phenomenon that often happens during satellite-linked telephone calls. It occurs when a speaker can hear his or her own voice as it's being downlinked to the other party, which takes .6 seconds. This echo makes it difficult to hold a conversation.

Satellite Frequency
Since satellites are basically radio receivers and transmitters, they are tuned to certain frequency ranges (called bands) just like home stereo receivers. Radio waves are expressed in cycles per second, or Hertz (Hz). Signals that satellites can process are called microwaves, which are frequencies that transmit several billion wave cycles every second. A common frequency range for an uplink is 5.925 to 6.425 gigahertz (GHz), or about 5.9 to 6.4 billion cycles per second. The corresponding downlink transmits frequencies from 3.7 to 4.2 GHz. An uplink and downlink working within these parameters operates on the C band. The K band is another frequency range that satellites often use. The K band operates at higher frequencies than the C band. Its frequencies range between 14 to 14.5 GHz for an uplink and 11.7 to 12.2 GHz for the downlink. Though other bands of frequencies exist, these are the most frequently used because of their reliability and relative immunity to adverse atmospheric effects.

Satellite Orbits
Because of the limited strength of booster rockets, early satellites were placed in low orbits (less than 600 miles from Earth) or medium orbits (less than 6,000 miles from Earth). An ideal distance for a communication satellite to orbit is 22,300 miles from the surface of the Earth. This orbit is called geosynchronous because it allows the satellite to orbit the Earth at the exact rate at which the Earth is spinning. If a geosynchronous satellite is located directly above the equator, its position remains fixed in reference to any point on the Earth. This orbit is called geostationary. By 1963 a geostationary satellite was orbiting the Earth.

Geostationary satellites have a distinct advantage over satellites with greater or lesser orbital distances from the Earth. An antenna fixed on a particular geostationary satellite will not lose contact with it, since from the antenna's vantage point on Earth, the satellite appears in the same place in the sky. Satellites with non-geostationary orbits only make contact with earth stations for short periods each day. These satellites orbit the Earth faster or slower than the Earth spins on its axis, so they will pass over an earth station or the earth station will pass by the satellite. Either way contact with the satellite is broken.

Also, at a geostationary orbit, the area that a satellite can cover — called a footprint — is greater than at lower orbits. A geostationary satellite can keep in constant contact with approximately 40 percent of the Earth at one time. By arranging a network of three satellites 120 degrees apart around the Earth, a nearly global communication network is established.

Most satellites today are launched on multi-stage booster rockets that bring them into the correct orbit. The space shuttle also launches satellites. Because the shuttle does not achieve the altitudes necessary for geostationary orbits, satellites must then be guided into proper orbit by a booster rocket.

A satellite may be pushed out of its correct position by solar winds or other cosmic interference. Remote controls on Earth fire thrusters attached to the satellite to readjust the direction it is pointing, called the attitude. Thrusters are also used to return the satellite to its proper location, called station keeping.

Generally, the sun provides power to satellites. However, there are two periods every year when the Earth comes between the sun and a satellite, which casts a shadow over the satellite's photo-electric solar panels and deprives the spacecraft of energy. These periods can last more than an hour. In such situations, backup batteries are activated to supply the spacecraft with power. Experimental satellites that can harness the power of radioactive isotopes floating in space as a power source are also being tested.

Satellite Applications

Traditionally, satellites have been used for long distance communication service as well as to link specific areas. Domestic satellites supply communication to particular areas, usually within national boundaries. The TELESAT satellite, for example, helped provide Canada's remote, sparsely populated areas with the same television and long distance telephone services enjoyed by the rest of the nation. Television networks, such as ABC, NBC and HBO, use domestic satellites to beam their signals across the United States so regional station affiliates or cable television providers can pick up their signals.

Regional satellites can be shared by many users, such as various nations. They serve wider areas than domestic satellites and create an international network, permitting global satellite communication.

Increasingly, satellite service has been harnessed by smaller groups of people and by individuals. Corporations use satellite technology to broadcast data or video signals to their regional affiliates. In these systems, businesses lease satellite time from corporations that own satellites. Earth-station antennas are located at various offices for uplinking and downlinking information.

By using a satellite master antenna television (SMATV), also called wireless cable, closed-circuit satellite television service can be provided to a small group of people in an office building or on a campus using one earth-station antenna.

Similarly, very small aperture terminals (VSATs) are used for transmissions between specific sites. Satellites send very tightly focused uplink and downlink transmission beams, providing direct links between two sites. VSATs are frequently found in the business community because they allow a central office to directly communicate with affiliate offices.

As earth-station antennas have become smaller, they have also become portable. The most famous example of the portable antenna's usefulness was during the Gulf War, when newscasters used these portable uplinks to broadcast live television coverage from the Middle East to a worldwide audience.

Satellite systems have also facilitated the development of mobile communication. Ships, cars and airplanes are able to place telephone calls while moving by using satellite uplinks. Although land-based mobile systems already widely exist for cars, pagers and portable phones, satellites can augment these systems because they can provide a greater range of communication options. For instance, satellite systems that connect land-based wireless systems will allow pagers that display written information to be used no matter where the person holding the pager is located. Without such technology, land-based mobile systems are limited to a specific area of coverage. As advanced digital services become available, satellites in lower orbits will also provide transmission of any type of medium — voice, words, video — to any mobile communication device.

Motorola, a manufacturer of wireless systems, has developed plans for such a satellite-based phone and paging system. Because this system, called Iridium, uses low-orbiting satellites, the company will need to launch at least 66 satellites to provide truly global service. The telephone that Iridium uses allows a caller to place calls through the local phone company or through satellites.

Direct broadcast satellite (DBS) is another way individuals can harness the power of satellite transmissions. DBS provides cable television programming through an earth-station antenna about two feet in diameter that attaches to a rooftop. Antennas about the size of a half-dollar have also been developed for satellite radio transmission to automobiles. Similar to DBS, satellite radio offers CD quality sound to subscribers who pay monthly fees to the service provider.

But regardless of what type of signal satellites transmit — telephone, television, radio — the satellite itself operates the same way in most cases. Signals are beamed to a satellite from Earth, transponders convert the frequency of the signal and send it back to one, or perhaps many, different locations on Earth. This conceptually simple process is the basis for our worldwide communication network.

u contributed by Christopher LaMorte

Communication Satellite Industry

Communication satellites have traditionally been associated with government, large corporate communications and television. However, new developments in direct broadcasting to homes and personal communication technology are changing the communication satellite business. The $6.5 billion industry includes the design and construction of satellites, launch services, ground equipment, owners of communication satellites and companies that use the birds to provide video, voice and data communications.

Satellite Manufacturing

The big three in satellite manufacturing are GM Hughes; Space Systems/Loral (SSL), a conglomeration of U.S., Italian, French and German companies; and Lockheed Martin, the result of a 1995 merger of Lockheed and Martin-Marietta. These three companies dominate the worldwide industry that builds geosynchronous communication satellites, with GM Hughes at the top, controlling approximately one-third of the total market. TRW, Orbital Sciences, Rockwell and Defense Systems International focus on smaller, non-geosynchronous satellite applications; however, each is also involved in many other aspects of satellite construction and launching. These primary contractors are supported by many subcontractors that build the specialized parts and components that make up the satellites.

Although historically American manufacturers have dominated the industry, this lead has recently been eroded by competitors in Asia and Europe. In 1992, U.S. companies built 73 percent of the communication satellites produced in the world; in 1993 they got contracts to build 69 percent of the 99 communication satellites that were ordered.

Satellites have gotten more efficient by applying new technologies to increase transmission power, improve power storage, increase satellite life span and expand the number of transponders. According to the *World Space Markets Survey*, published by Euroconsult, at the end of the first quarter of 1994 there were 3,341 commercial transponders in orbit, excluding those on satellites belonging to the Commonwealth of Independent States (CIS), formerly the Union of Soviet Socialist Republics (U.S.SR). Industry experts say that C-band communication channels are being provided on 433 satellites and Ku-band communication channels are on 378 satellites, with some of these satellites outfitted with transponders for both bands. Satellites represent investments of up to $100 million, costs that can only be recouped by handling a wide variety of communication signals, from data to television.

Launches

Price affects not only the satellite manufacturers, but also the cost of launch services. New satellites are more efficient, but also heavier, and launch costs are directly related to launch weight. Estimates place the cost of a launch between $7,000 and $10,000 per pound, totaling $40 to $50 million for a small geostationary satellite and up to $120 million for a large one.

Since its inception, the U.S. satellite industry has been protected for national security reasons, and U.S.-built communication satellites could not be launched by certain foreign countries, in particular China and the CIS. But a new seven-year agreement between the United States and China authorizes up to 11 launches using their Long March launch vehicles, including geosynchronous and low earth orbit (LEO) launches. In addition to China, Japan, the CIS and European countries are stepping into the launch business. Even now, Arianespace, the European launch consortium based in France, launches approximately half of all communication satellites, and China's Long March rocket and the CIS Proton vehicle combine for about 20 percent of the launches. McDonnell Douglas and Lockheed Martin account for approximately 30 percent of all launches.

Even the U.S. Air Force is trying to reduce costs by relaxing restrictions on domestic commercial launches in hopes that it will, in turn, result in a reduction in the cost of military launches. Currently, 70 percent of the U.S. launches are military and 30 percent commercial. If the Air Force is successful, the ratio of military to commercial launches will reverse, and result in the commercial launches covering more of the military costs.

New rockets and launch techniques will also bring down the cost of launches. For example, the recent launch of a satellite using a large, commercial-type jet aircraft as the launch platform for the rocket and its payload could prove to cut the costs of putting a satellite into LEO.

Annually there are approximately 30 communication satellite launches worldwide; however, the emergence of direct broadcast satellite (DBS) television and personal communication services (PCS) using low-earth orbit (LEO) satellites could increase launch traffic tremendously.

Expanding Global Communications

Six companies have filed with the Federal Communications Commission (FCC) for licenses to build and operate personal communication satellite networks called Little LEOs: Orbital Communications; CTA Commercial Systems, Inc.; E-SAT, Inc.; Final Analysis Communications Services, Inc.; GE American Communications; and Orbcomm. Applications for licenses to build and operate larger networks of Big LEOs have been submitted by five companies: Constellation Communications, with a network of 46 satellites; Motorola's Iridium project, with 66 satellites; Loral/Qualcomm's Globalstar, with 46 satellites; Mobile Communications Holdings' Ellipso system, with 16 satellites; and TRW's Odyssey system, with 12 satellites. Of these, only Iridium, Globalstar and Odyssey have received FCC approval and only Globalstar has deployed satellites. Teledisc, a network proposed by William Bill Gates of Microsoft and Craig McCaw, former owner of McCaw Cellular Communications, is considering launching 900 satellites, with 840 in operation at once. The International Maritime Satellite Organization (INMARSAT) is also pursuing a global network for personal communications, called INMARSAT-P, that would be made up of 12 satellites.

Although competition for customers and the realities of the marketplace will probably reduce the numbers involved, if all of the Big LEO global networks for personal communication are able to get up and running, that segment of the industry alone will put 1,098 satellites into low-earth orbit. McDonnell Douglas has launch contracts for Motorola's Iridium project totaling $400 million for eight launches from late 1996 through late 1997. Each launch will place five satellites in low-earth orbit, for a total of 40 satellites by the end of 1997.

Since the large number of satellites projected by the builders of these communication networks would skew estimates dramatically and the actual launch of all the satellites is questionable, industry experts do not always include them in projections for the future.

The other technology that has already had an impact on the communication satellite industry is direct broadcast satellite (DBS). GM Hughes Electronics, a partner in DIRECTV, launched two DBS satellites in 1994, adding to its constellation of commercial satellites that is already the largest in the world. From 1994 to 1996, the DBS industry is projected to launch 12 satellites that can deliver up to 150 channels of television programming directly to home receivers.

Mergers and Partnerships

Like any industry that is maturing and experiencing growth simultaneously, satellite manufacturing is involved in a cycle of mergers, acquisitions and partnerships. General Electric acquired RCA Astro-Electronics in 1986. Also in 1986, AT&T bought Ford Aerospace Satellite Services Corporation, a Ford subsidiary that did not include any manufacturing capability. Loral Corporation bought Goodyear Aerospace in 1987 and the 40-year old Ford Aerospace manufacturing company in 1990, and then entered a joint venture with two CIS aerospace companies to launch radio and television satellites for a European satellite company in 1994. In 1993, Martin-Marietta bought GE's Astro Space Division, then teamed up with Lockheed two years later to create a company with massive experience in communication satellite production and launch vehicle construction. Of the 641 communication satellites that have been announced, funded or slated to launch between 1994 and 2004, Lockheed has contracts to build 126 of them.

The U.S. satellite manufacturing industry has a long history that has been inherently tied to the U.S. space program (manned, unmanned and planetary exploration) and defense contracts. With decreases in defense spending, it remains to be seen whether these leaner companies can continue to dominate the communication satellite industry, or whether other countries will move into the forefront.

Ground Equipment and Communication Services

Although they are two separate segments of the communication satellite industry, ground equipment and communication services are so closely linked by technology that change in one drives the evolution of the other.

Even though hundreds of companies use communication satellites, only five U.S. companies own orbiting domestic satellites: Alascom, General Electric American Communications, Hughes Communications, Inc., AT&T and COMSAT General. Together, they own 25 percent of the worldwide capacity — 34 satellites with 707 transponders. Less than half (45 percent) of the total satellite transponder time that is available is committed to full-time use by television, radio and private networks. The remaining 55 percent is used on an as-needed basis at an hourly cost ranging from $200 to $600, depending on time of day and signal bandwidth.

Although ground equipment for communication satellites used to include 100-foot diameter dishes and ancillary equipment that would fill a baseball stadium, changes in satellite technology have reduced some dishes to the size of a large kitchen skillet, and the drive toward size reduction is far from over.

In 1993, the revenues from ground equipment were estimated to have been $1.6 billion, with 55 percent of the total coming from complete earth stations, those large antennas and facilities that characterize the industry. Video applications, the largest segment of the ground equipment industry, accounted for $545 million of the 1993 revenue. Video will continue to be substantial, bolstered by the construction of teleports, which are large transmission and reception facilities that link businesses via private and commercial networks. Teleports are enabling companies to transmit data and video from the corporate office to branch offices across the country (point to multipoint), and communications from all of those branch offices back to the corporate headquarters (multipoint to point). Teleports are operating in Los Angeles, San Francisco, Dallas, Chicago, Washington, D.C. and New York, with plans for one to be built in Denver by COMSAT.

U.S. companies control 50 percent of the growing ground equipment market, estimated to be $3.8 billion in 1995. The ground equipment industry now includes seven areas: very small aperture terminals (VSAT), television receive only (TVRO) dishes, DBS antennas, mobile satellite receivers, antennas for land mobile satellite services (LMSS), receivers for global positioning services and equipment for the emerging global personal communication industry.

Private networks are using VSATs, one- to two-meter dishes that are installed on the roofs of stores and offices. In 1993, 103,000 of the terminals were installed, up 28 percent from 1992. The terminals were used to create 270 VSAT networks in the United States alone, and generate $45 million in revenues. U.S. manufacturers supply 85 percent of the world market for VSATs.

In the United States, VSAT networks are used by retailers to check store inventories, by insurance companies to process claims and by many companies for video conferencing. Ford Motor Company is installing 6,000 VSATs at its dealerships to create the largest interactively connected training network, which will transmit eight channels simultaneously.

Five companies provide most of the VSAT services, including Hughes Network Systems, AT&T Tridom, GE Americom, Orion Atlantic and Scientific-Atlanta. The VSAT market in the United States has leveled off; however, Europe, Asia, South America and the Mideast are incorporating VSAT communications at a furious pace. For years, governments of foreign countries prohibited VSAT networks within their borders. In recent years they have relaxed their opposition, and in 1993 there were 120 VSAT networks in foreign countries. Experts predict that 50,000 terminals will be in place in Europe alone by the year 2000.

TVROs, those two-meter satellite dishes that look like giant colanders for draining vegetables, gained popularity in the 1980’s, then tapered off as networks like HBO, Showtime and Cinemax began scrambling their channels in such a way that unauthorized reception was all but impossible. Manufacturing of TVROs has long been dominated by the United States; however, Japan, South Korea and Hong Kong are capturing large pieces of the market. Approximately four million TVROs are in use in the United States, but DBS services are expected to eat into the TVRO market.

Three DBS companies began providing service in 1994, including DIRECTV, a subsidiary of Hughes Electronics; PRIMESTAR, owned by a conglomerate of cable television companies; and United States Satellite Broadcasting (USSB), a subsidiary of Hubbard Broadcasting. DBS is expected to have an effect on not only the TVRO market, but also the cable television customer base. As DBS evolves and signal compression increases the channel and information carrying capacity of the satellites to 150 channels, DBS could become able to deliver video telephony to homes and video to theaters, provide computer access to libraries and publishers, and distribute many channels of audio to homes and stores.

Although companies like Muzak and Seeburg Satellite Music Network already distribute music to stores and buildings via satellite, DBS providers and five additional U.S. companies are proposing a new twist on audio distribution, called direct audio broadcasting (DAB) or digital audio radio service (DARS). American Mobile Radio Corporation; Digital Satellite Broadcasting Corporation; Primosphere Limited; and CD Radio, Inc. are looking at distributing up to 30 channels that could be picked up by receivers the size of a playing card. Primestar already offers its subscribers 12 audio channels from SUPERRADIO Cable Radio Service, provided by Jones Galactic Radio, Inc., a subsidiary of Jones Intercable.

Other Services
Mobile satellite communications, which allow voice and data communications for a variety of ocean-going ships, off-shore oil rigs, and aircraft, are also on the brink of immense growth. The International Maritime Satellite Organization (INMARSAT), which has been in the mobile satellite communication business since the 1980's, has recently expanded into aircraft communications via satellite. In 1993, more than 30,000 mobile satellite receivers were in use on ships and oil rigs worldwide. Expanded services and reduced costs for the antennas are creating optimism that a ten-fold increase in users is possible by 1995. Annual revenue could reach $20 billion, $11 billion of which would go for the satellites and launches. By the year 2000, 3,500 aircraft are also expected to use INMARSAT services for two-way video, voice and data communications.

Land mobile satellite services (LMSS) include the above DAB and a variety of data and voice communications. Vehicle-mounted receivers, predominately used for location and data transmission by shipping companies, use communication satellites to transmit and receive signals from central locations. Qualcomm's Omnitracs services package shippers, and in 1993 it had 60,000 units in use, allowing freight companies to track vehicles and individual packages. Mobile Data and American Mobile Satellite Corporation are joining Qualcomm in expanding LMSS into a variety of other services.

Another growing segment of satellite communications is global positioning. Over 500,000 Japanese smart cars have devices installed that tell the driver where the car is. Just recently, the United States has allowed limited use of its extensive global positioning satellite (GPS) system, which enables private individuals to pinpoint their location within 100 meters. Although the accuracy is sufficient for use by private citizens, it is only a fraction of the capability of the tightly guarded military GPS system. The Commonwealth of Independent States intends to institute a GPS service that would compete with the U.S. system and could offer greater accuracy.

Personal communication services (PCS) are now using microcell technology and are terrestrial-based, relying on systems of antennas interlinked by fiber-optic and coaxial cable. Projects like Iridium, Teledisc, Odyssey and others; however, are moving PCS into the realm of satellite communications. Doing so will enable users to communicate with people anywhere in the world. All of the proposed global PCS systems will use satellites in low-earth orbit, with some systems routing calls to cellular-like antenna networks on Earth before going to the person called and others transmitting signals between satellites, and only returning the signal to Earth when the receiver is found.

Future Developments

The communication satellite industry, including design and manufacturing, ground equipment, and service providers, is tightly linked together — expansions in service are dependent upon technological capability, and advancements in capability depend upon demand for services that can pay the costs. As the wireless communications industry expands and satellites are used to deliver some of those services, the industry could grow tremendously. But there is a competitor to communication satellites: fiber-optic cable. More and more of the domestic and international communication traffic, including voice, data and video, is being carried by fiber-optic networks.

Current discussions of the information superhighway are based on terrestrial networks of fiber-optic and coaxial cable, with communication satellites seldom mentioned as an element in the new wave of communications. Yet communication satellites are often used to transmit video and data, and at costs lower than using land lines. To be a major player in the revolution, the communication satellite industry must dispel the twin myths that it is neither cost competitive nor reliable.

The satellite industry is always a game of supply and demand. The current supply of Ku-band transponders will become a scarcity as C-band services migrate to Ku-band frequencies and gobble up the wider bandwidth. As older satellites run out of propulsion fuel and their orbits decay, they will eventually fall into the atmosphere, burn up and be replaced by new generation satellites that are more powerful and have more transponders. This cycle, which for the present is inevitable, will probably provide a steady 4 to 5 percent growth in the industry.

The advanced communication technology satellites (ACTS), which have been in orbit since 1992, are proving new technologies, such as on-board signal switching, on-demand channel assignments and automatic compensation for attenuation due to weather. New technologies will also give satellites better batteries to store power and solid-state electronics that consume less power; increase the power of on-board transmitters and continue the size reduction of receivers; and enable the installation of efficient xenon ion engines and refuelable propulsion systems. It is expected that each new generation of geostationary satellites will lengthen the average 12- to 14-year life span of current satellites by two or more years. The recent launch of a satellite by using a jet as the take-off platform and research into reusable launch vehicles could reduce launch costs considerably.

As these and other technologies are developed and incorporated into future satellites, they can be used to monitor power lines, provide broadband video links to aircraft and even transmit live video from a battlefield. ACTS tests have already had an effect on the design of Iridium’s satellite-to-satellite signal transmissions.

New services, if and when they are established, can fund these changes and propel this vigorous industry into an environment of growth and competition.

u contributed by Paul Stranahan

Common Carriers

Companies who transmit voice, data, or video over company-owned lines and charge established rates, called tariffs, to carry these signals. Common carriers are subject to Federal Communications Commission (FCC) regulation of their tariffs and the services they can provide.

For example, telephone companies are common carriers because they provide specific services, charge set rates for those services, and anyone can use their systems. Cable television (CATV) systems are not common carriers, because they are not available to carry signals for anyone who wants to use their systems, they do not have specific transmission services to offer, and have no set rates for carrying a signal.

Typically, common carriers have no control over the content of the signals that their systems carry.

u contributed by Paul Stranahan

Communications Act of 1934

The definitive communications policy in the United States. Adopted by Congress in 1934 as broadcasting was rapidly developing and amended many times since, this legislation provides the parameters for all regulation and licensing of wired and wireless communications and creates a single administrative agency responsible for implementing federal communications policy, the Federal Communications Commission (FCC).

The FCC's broad responsibilities include promulgating necessary regulations to carry out the provisions of the Act and the licensing of persons and/or businesses that engage in a variety of communications services. The Act establishes the jurisdictional boundaries between the federal government and the states in their respective oversight of communications activities. The Act's objective, in part, is to provide the foundation for a national policy governing the availability of communications services (including telephone and telegraph services; radio services; and broadcast, cable and satellite television services) at reasonable prices.

As outlined, the FCC's overriding responsibility is to ensure that the private owners of these interstate (and frequently international) communications services operate in the public interest.

The FCC has sole responsibility under the Act to license the use of "public airwaves" or the radio electromagnetic spectrum over which all radio (and over-the-air television and telephone) services are transmitted.

In the broadcast arena, specific FCC responsibilities include classifying and licensing radio and television stations and directing the nature of their services. The actual content of broadcast services, however, generally is protected from government interference under the First Amendment. The FCC also determines each station's type of facilities, times of operation and service area. Most importantly, the Commission allocates portions of the electromagnetic spectrum to various classes of licensees and assigns their operating frequencies.

The FCC's regulations are intended to ensure that the licensee operates in the public interest and to protect broadcast licensees from interfering with one another in the transmission of radio and television signals. The provisions of the Act involving broadcast services walk a careful line between imposing regulations to protect and serve the public interest and a sensitivity to the dictates of the First Amendment. Freedom of speech mandates that the broadcaster be generally protected from censorship by the FCC; the public interest demands that the public be protected from obscene and indecent programming. A similar "balance" arises over provisions designed to serve the political process which require that equal opportunities be provided to candidates for public office to access radio and television broadcast services.

With regard to telephony services, the FCC is empowered to evaluate the need for facilities, set the rules of operation and oversee charges to consumers and users of those facilities. "Common carrier" facilities must be available on a non-discriminatory basis to all potential users and the FCC oversees the accounting and operation of those entities to ensure their availability at reasonable prices. The FCC also has jurisdiction to prohibit obscene or harassing telephone calls as well as to oversee services for the hearing and/or speech impaired. Unlike broadcasting, however, the FCC's jurisdiction over telephone service providers is shared to a degree with state government agencies.

Radio and television broadcast facilities use the electromagnetic spectrum to transmit their services and, therefore, those services are considered to be wholly interstate in nature. Telephone services, on the other hand, can be both local and interstate in nature. And, importantly, the telephone facilities are constructed along a series of public and private rights-of-way. Therefore, the Act empowers the state governments to regulate the intrastate portion of telephony facilities and services. Historically, facilities and services provided by telephone companies have not involved the provision of information or "content" services transmitted over telephone company facilities. Regulation of telephone companies as facilities providers resulted in few instances in which the First Amendment was implicated by implementation of the Communications Act. As telephone service providers begin offering information or content services, issues associated with freedom of speech will necessarily rise in importance.

In the area of cable television, the Act again provides for both federal and state jurisdiction over service providers. While the state or local jurisdiction is empowered to actually issue the franchise to a potential cable operator, the Act sets forth the boundaries of what can and cannot be required as part of that agreement. The FCC is responsible for setting standards for the regulation of rates (which are implemented, in part, at the local level) and implementation of federal law governing much of the operations of cable systems, including mandatory carriage of local broadcast signals, channel lease arrangements, technical and customer service standards, access to cable programming services by cable's competitors, and rules on subscriber privacy and equal employment opportunities. As with the provisions governing broadcast services, because cable operators provide both facilities and the programming transmitted over those facilities, the Act's provisions relating to cable television reflect certain First Amendment implications of government regulation of speech.

The Communications Act of 1934, as amended, currently has seven sections called "titles." Broadly speaking, Title I defines the terms and covers the FCC's structure and operation; Title II regulates common carriers — generally providers of telegraphy and telephone services; Title III concerns broadcast services (both commercial and educational, including public broadcast services), which include mobile radio services, certain ship-board radio services, and direct broadcast satellite services, and the creation of the Corporation for Public Broadcasting; Title IV covers provisions for FCC procedures and administration; Title V contains penal provisions; Title VI governs cable television operators; and Title VII contains miscellaneous provisions including prohibitions against unauthorized publication of communications and a description of presidential powers during war emergencies.

The Communications Act of 1934 has been amended periodically, especially to reflect the introduction of new services and new technologies. Significant changes over the past 60 years include the Communications Satellite Act, the Educational Television Facilities Act, the All-Channel Television Receiver Act, and the Cable Communications Policy Act. Currently under consideration in both Houses of Congress is a major overhaul of the Act to reflect the perceived need for changes in telecommunications policy brought on, in large part, by the growing convergence of telephone, cable and wireless services.

u contributed by JDC Editorial Staff

Competitive Access Providers

Originally, competitive access providers (CAPs) were defined as companies that supplied dedicated telephone transmission facilities directly to large commercial customers and long-distance carriers (also known as interexchange carriers or IXCs). In addition, they sometimes provided the transmission facilities between switching offices. This put them in direct competition with local telephone companies (also known as local exchange companies or LECs) because a CAP's circuits would bypass the LEC's network to connect customers to the interexchange carriers. But CAP's definition and view of themselves is evolving into that of independent telephone companies. They've moved from just providing an alternate access to long-distance services for some major businesses to competing with the local exchange companies (LECs) for all kinds of local telephone service.

History of CAPs

To understand CAPs, it is necessary to take a brief look at their history. After the 1984 AT&T divestiture, the field was open for competition in the long-distance market. Many companies entered this competitive arena, but all had to deal with the LECs for access to individual customers. In 1985, CAPs saw an opportunity to bypass the LECs by building their own private network of sophisticated fiber-optic cable. Using advanced digital transmissions they connected some major businesses to long-distance carriers.

Although this worked well for high-volume businesses in large cities, the CAPs soon began to realize that to expand their client base, they needed access to a larger number of customers and that access would have to come through the LECs. In 1986, New Jersey Bell and Teleport Communications Group (TCG), one of the first and most successful CAPs, reached the first LEC/CAP agreement for central office interconnection. This precedent-setting deal allowed TCG to serve customers outside its own network by paying to use New Jersey Bell's local connections.

The CAPs continued to push for interconnection with the LECs. In 1988, TCG co-founded the Association of Local Telecommunications Services (ALTS). This group's purpose was to allow the CAPs to bring major industry issues to the attention of Congressional legislators and Capitol Hill policy makers. In 1989, Metropolitan Fiber Systems Inc. (MFS), another major CAP, petitioned the Federal Communications Commission (FCC) to establish rules and prices governing the interconnection of non LEC facilities and LEC local networks. On June 6, 1991, the FCC released a Notice of Proposed Rulemaking and Notice of Inquiry to elicit comments from the telecommunications industry on competition in interstate-exchange access services.

The seven regional Bell operating companies (RBOCs), who were the major LECs affected by the ruling, split on their reaction to this legislation. Some reacted positively, hoping that by opening their central offices to interconnection, they would be opening the door for their own entry into more competitive arenas. Others fought hard to keep the CAPs out of their buildings and away from their customers. On October 19, 1992, the FCC released its Special Access Interconnection Order, requiring all LECs with annual revenues of $100 million or more from regulated telecommunications operations to provide physical co-location arrangements and interconnection to special access service providers.

Under the FCC ruling, co-location (sometimes spelled collocation) required that the LECs provide CAPs with a “reasonable” amount of their central office floor space to install transmission facilities and equipment. Before the FCC mandate, all interconnections to the LEC network occurred at the customer premises; the LEC provided circuit transport between the central office and customer premises, as well as the electronic equipment needed to terminate the circuit in the central office. CAPs could provide only services that bypassed the LEC’s network completely. For example, CAPs could interconnect multiple customer premises (to create a wide area network) or provide connections between customer premises and an interexchange carrier office.

Making Co-location Work

To make co-location work, circuits are routed from CAP equipment in the central office to the LEC’s equipment for access into the LEC network. The CAP equipment is often placed inside a mesh partition enclosure, segregating CAP and LEC floor space and providing security. LEC circuits carry interstate special service traffic from the customer’s location to the central office; then CAP circuits complete the connection to another customer premises or to an interexchange carrier. This allows CAPs to offer services to more customers and locations without duplicating existing LEC loop facilities.

On February 16, 1993, the LECs filed their tariffs implementing the FCC’s Expanded Interconnection Order for special access. To counteract this forced interconnection, many of the RBOCs made it more expensive for CAPs to interconnect to RBOC networks than to purchase the same service end-to-end from the RBOCs on a retail basis. The FCC ruling also gave LECs pricing flexibility in the form of zone density pricing plans that allowed LECs to create rate zones where they could set rates at varying levels based upon density of the customer base and the presence of competition. In zone density pricing, the LECs were permitted to reduce rates in the most competitive of zones by up to 10%, correspondingly raising rates in the least competitive zones by up to 5%.

Four RBOCs and five independent telephone companies protested to the courts. But CAP penetration kept growing, and by 1993, more than 20 separately managed CAPs provided service in over 40 cities. In June 1994, the Federal Court of Appeals overturned the FCC’s original decision. The FCC subsequently adopted new provisions that required the RBOCs to offer “virtual co-location” if physical co-location was not feasible due to space or cost limitations. With virtual co-location, the interface between the LEC and CAP is placed outside the central office. This is typically done using a fiber splice of the LEC and CAP facilities in a leased premises or manhole as close to the central office as possible, usually within 1/8 mile. The CAP specifies what terminating equipment will be used in the central office for these fiber facilities, although the LEC is responsible for that equipment’s operation and maintenance.

But the CAPs knew this wasn’t enough to ensure their survival, and they began to look into providing local telephone service in direct competition with the LECs. In 1991, TCG became the first CAP to launch competitive switched services in New York through two Class 5 digital switches. And the CAPs began focusing on the state Public Utility Commissions (PUCs), where they hoped to gain equality with the incumbent telephone companies.

The CAP Future

Although united in their desire to get into the local telephone business, the CAPs are not united in their approach to how or where they will enter it. The strategies of the two top CAPs (MFS and TCG) follow two patterns. MFS's strategy revolves around winning complete co-carrier status. This includes a variety of conditions, such as allocating blocks of telephone number prefixes to CAPs. MFS wants to be treated as an independent telephone company and share in the RBOCs' assets. TCG's strategy is to apply for authorization for specific services, not full co-carrier designation. The company is asking for just what it needs to do certain aspects of the telephone business, not to change all of the telecommunication policies.

However, both of these strategies may become unnecessary with new laws and subsequent rulings from the FCC. In 1995, several bills were introduced into the U.S. Congress that would give the FCC authority to preempt state public utility commissions (PUCs) in opening up the local loop. CAPs are generally supportive of federal preemption and want help in states where regulators are hostile to competitors. CAPs are, however, concerned that the federal solutions would give them less than what they are already getting in the more competitive-friendly states (for example, Illinois and New York).

Another major stumbling block for the CAPs is being overcome. Although some of the CAPs, such as MFS and TCG, are substantial businesses, their resources don't begin to compare with the RBOCs. This hampers their ability to grow and enter new markets. Coming to their aid are the cable television and interexchange companies. The major interexchange players, such as AT&T, MCI, and Sprint, see the CAPs as one way to avoid the high access fees charged by the LECs. And, if the cable companies can interconnect their residential networks with the CAP business networks, together they can compete equally with the LECs in metropolitan areas. Interconnected cable-CAP networks could hand off and receive traffic from an interexchange company, an end-user's premises or a co-located point-of-interconnection in a LEC central office. Mergers, partnerships and alliances are now being formed. The interexchange and cable companies are providing additional resources and the CAPs are getting increased access. Between them, they are beginning to provide even more services in direct competition to those provided by the LECs.

But another, unexpected, player is also coming to the CAPs with partnership offers. Some of the LECs are looking to a future when they will be allowed to compete with other LECs to provide local service out of their regions and compete with the interexchange carriers to provide long-distance service. By partnering with CAPs who are already entrenched outside their operating regions, RBOCs that wish to expand have a "foot in the door."

So what does the future hold? The more successful of the CAPs will probably grow into something else. Two new acronyms are already being used in the industry — *national competitive access provider* (NATCAP) and *competitive local exchange carrier* (COMPLEC). A NATCAP takes today's CAP services into a broader area, offering regional services in addition to downtown fiber-optic rings — and does it in major local markets around the country. Its customer list is largely based on those who view the LECs as competitors: companies such as AT&T, MCI, Sprint and other long-distance phone companies. That list will grow because, as regulators grant the LECs more freedom, the LECs will move beyond their traditional telephone business. A COMPLEC is really just another telephone company, one that offers the same services as the local telephone company to someone who wants a choice for local service.

Challenges Facing CAPs

There are still some basic problems that need to be resolved. One that seriously concerns the government, the LECs and the CAPs is the issue of universal service. Much of the basic telephone service customer base of the RBOCs and LECs remains unattractive to the CAPs because it contains low revenue generators. CAPs have been criticized by LECs for targeting high-volume business customers but not sharing the burden of providing service to high-cost customers (such as rural) or low-income customers who are unable to afford service. How to maintain universal service (basic telephone service to everyone) continually surfaces as a stumbling block when government regulators consider fully competitive local access.

The CAPs believe the only fair solution is to create a universal service subsidy fund managed by an independent institution to which all carriers contribute and from which all carriers can draw to fund appropriate subsidized service. The money would be used to subsidize people who can't afford basic telephone service or who live in rural areas where it is more expensive to provide service. Universal service is a major issue to be resolved before total competition on the local service level is established.

Other unresolved issues include number portability, equal status and regulation. To make full competition truly feasible, competitors must work together to devise a system wherein customers can change service providers without changing phone numbers (number portability). Though technically difficult to achieve, portability is possible if all of the carriers in a region cooperate. The issues of equal status and regulation center around the same thing. CAPs claim that for customers to have a real choice, all LECs must deal with alternate local carriers as peers, just like the long-distance companies do, and the regulatory requirements and restrictions for CAPs and LECs must be the same. In 1995, Congress is considering bills that would deal with some of these regulatory issues.

One last concern that has been raised by both the U.S. government and Wall Street is whether the country can afford two competitive wires into every home or business. There is some thought that there should be only one wire, which is LEC-owned, to the home and that the competition should be for other services. How this view will affect regulation over the next few years is yet to be seen.

The subject of CAPs is indeed a complicated one. This is an industry in a state of evolution. The term itself may not even exist in a few years. But whether CAPs will be something brand new or just a new version of something old won't be known immediately. All that is certain is that changes will occur in the industry.

u contributed by Linda Stranahan

Computer Memory

Computer memory usually refers to the area in computer circuitry that holds data and instructions that the computer is currently using. More broadly, memory can also refer to long-term storage methods, such as floppy or compact disks.

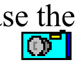
One measure of a computer's capabilities is the size of its memory. There are two types of memory: primary and secondary. Although secondary memory (also called storage) provides long-term memory for computer data and instructions, primary storage (often referred to as main memory, or more simply as memory) has a direct impact on how a computer processes data and how much it can process at one time. Stored on microchips, memory contains information on a computer's operating system and the instructions that are currently being processed, as well as the data that is being added to a computer.

Early computer memory consisted of magnetic rings that were magnetized in ways that could represent data. By charging a row of these rings in a positive or negative direction, the cores could be made to represent binary digits. Core memory was used until the mid-1970's, when integrated circuits were developed. Integrated circuits were able to more efficiently hold data.

Random Access Memory
Random access memory (RAM), a type of memory contained on a microchip (or chip, also called an integrated circuit) is the computer's way of holding information that it is currently using. It is called random because instead of retrieving each piece of data sequentially, as it does on magnetic tape or in the way humans read lines of text, data can be retrieved from any memory location at any time. Today, the average RAM chip holds from 1 to 8 million bits of data.

The problem with RAM, however, is that it is volatile, meaning it cannot hold data permanently. As soon as the electric current is shut off, all the data is erased. If you are working on a long word processing document, for example, all your information is in RAM until you execute the save command, which stores the information more securely on a disk. If the power went out, or if your dog tripped over the power cord and unplugged your computer, all your data in RAM would be lost. A disk's memory, on the other hand, is not affected by the absence of electricity.

There are two types of RAM: Dynamic Random Access Memory (or DRAM) and Static Random Access Memory (SRAM). DRAM chips are the more common RAM chip. They are called dynamic because the electric charges that allow information to be stored on the chip must constantly be recharged. Although slower than SRAM chips, DRAM chips can hold more data and are much cheaper to manufacture. SRAM, however, is faster. SRAM chips are used as intermediary chips, called RAM cache. These help speed the process of data retrieval by the central processing unit (CPU) and speed some calculations.

The amount of RAM determines the size of programs that can be run and how much data can be input into a program at one time. In order to increase the amount of RAM, newer computers use Single In Line Memory Modules (SIMM)  . These chips increase computer memory in increments of 256 klobytes, or 1, 2, 3, or 8 megabytes.

Read Only Memory

Read Only Memory (ROM) is another type of memory found in computers. ROM differs from RAM in two important ways. Unlike RAM, new information cannot be added to ROM, hence the name “read only memory.” Also, instructions and data are permanently stored in ROM circuitry and remain the same regardless of whether the power is on or off. Therefore, ROM is an excellent way to store important programs and data that the computer manufacturer never wants altered. For example, a portion of a computer’s operating system (the programs that tell your computer how to act when you turn it on) is stored on ROM chips. Because the operating system is a program that is permanently stored on ROM chips, it is mid-way between software and hardware. It is often referred to as firmware.

Sometimes it is necessary to tell the ROM chips what information they will hold. Programmable Read Only Memory (PROM) chips come without any prior programming. With special equipment, hardware manufacturers can add data and instructions to these chips for permanent, unalterable storage. Two other types of ROM, erasable programmable read-only memory (EPROM) and electrically erasable programmable read-only memory (EEPROM), allow instructions to be altered under special circumstances. EPROM uses ultraviolet light to erase the contents, while EEPROM uses electronic means of erasing the chips. Programmers can store prototypes of their programs on such chips but alter them later if they want to change all or part of the programming code.

Like the rest of computer technology, new types of memory are being developed every day. Flash memory, for example, promises to replace hard disks as a permanent storage medium. Like magnetic and optical storage media, flash memory can store data even when the power is switched off. Flash memory is also smaller, faster, lighter, and more energy efficient than magnetic hard disk drives. Though portable computers have begun to take advantage of this technology, flash memory is still much more expensive than conventional memory, limiting its popularity and potential. Bubble memory is another relatively new technology that stores data for the long haul. It works by implanting microscopic bubbles on the microchip’s surface. The presence or absence of a bubble works in binary fashion to represent data. Like flash memory, it is still more expensive than conventional RAM, but it is used in situations where data loss would be devastating, and therefore using conventional RAM memory would be too risky.

u contributed by Christopher LaMorte

Operating Systems

Software programs that govern how computers operate are called operating systems. Operating systems are vitally important to computers--without them, computer systems cannot run.

An operating system is a collection of programs that govern how a computer works. These programs act as a bridge between computers and users, providing various functions and services that make the use of system hardware and peripherals safe, convenient and efficient. Operating systems also provide access to system resources; manage how these resources are used; and establish a stable, common platform for the use of application software.

Operating systems vary in size and structure, depending on the demands placed upon them and the size of the computer system they are designed to operate. Some can open only one program at a time on one computer; others allow multiple programs to run at the same time on networks or time-sharing systems.

Different computer systems use different operating systems. MS-DOS, an operating system introduced in the early 1980's by Microsoft Corporation, has been used in the vast majority of IBM-compatible personal computers (PCs) for years. It is known as a portable, or open, operating system, meaning that it can run on most microcomputers and support a variety of software applications. Although technically not an operating system, Windows, a graphical user interface (GUI) also developed by Microsoft, is a popular add-on to MS-DOS and is often used on newer PCs.

Unix, an operating system developed by AT&T in the late 1960's, is also an open system, capable of running on a number of different computers and allowing application programs to run on a full range of hardware platforms, from microcomputers to supercomputers.

Computer systems from Apple Computer, Inc. use an operating system specifically designed to run on these computers alone. This type of operating system, known as a proprietary system, will generally support only application programs designed specifically for these computers; however, some Apple computers are now manufactured with dual processing systems that allow them to support programs written for Macintosh, DOS and Windows. This is known as cross-platform compatibility.

Operating systems are composed of numerous layers. Each layer adds new operations to the computer while hiding selected operations at lower levels. Each layer also manages a set of software or hardware objects and defines the operations that can be carried out with those objects.

At the top level of every operating system is the system's basic working environment, also called an interface. This layer determines how information is exchanged between the computer and its users, and is the only part of the operating system most users will ever see. Many operating systems have GUIs, which feature easy-to-use icons and pull-down menus that guide users through the operations of the system. Other operating systems are command-, or text-driven, requiring users to memorize text and command screens to perform such tasks as deleting and copying files and displaying directory and file lists.

u contributed by Sonia Weiss

Computer Speed

Computer speed refers to how often a computer completes an instruction cycle and how many instructions it can complete during each cycle.

One measure of a computer's power is how fast it processes information. In fact, a computer's seemingly magical ability to manipulate words, numbers and graphics is based on its capacity to process an incredible amount of information &em; that is, instructions and data &em; at tremendous speed. Speed occupies such a central role in computer performance that computer engineers have created special ways of talking about it.

When discussing a computer's speed, it is important to know how many instructions or operations it can process per second. An instruction might be a command to store data, solve an arithmetic problem, or write a letter on the computer screen. A standard personal computer processes between 5 and 10 MIPS, or millions of instructions per second. The next generation of microprocessors, currently under development, promises to complete about 250 MIPS. Another more sophisticated measurement of microprocessor speed is expressed by measuring how many millions of floating-point calculations it can perform every second. This measurement is called MFLOPS, or millions of floating point operations per second. Some supercomputers, for example, can perform 40 MFLOPS or more.

Another way to determine how fast a computer operates is by measuring its clock speed. The clock paces the computer. Clock speed is measured by how long it takes the clock to complete a cycle. The faster the clock completes one cycle, the faster information passes through the computer. It may take the computer milliseconds (or 1/1,000 of a second) to complete a cycle, which is quite slow, or a fraction of a microsecond (1/1,000,000 of a second), which is very fast.

Clock speed is rated in megahertz (MHz), or millions of cycles per second. Top-of-the-line personal computers have microprocessors that work at 66 MHz or higher, or at least 66 million cycles per second. Plus, depending on the microprocessor, the amount of information it processes during each clock cycle varies. That's why the clock speed of a microprocessor is useful only when compared against the clock speed of a similar microprocessor. For example, an Intel 486 chip running at 33 MHz is faster than a 486 chip running at 25 MHz, but it does not process information as fast as an Intel Pentium chip running at 25 MHz . That is because although the Pentium chip may have a slower clock speed, it processes more data at every cycle than the 486 chip does.

u contributed by Christopher LaMorte

Computer Storage

Computer storage refers to the type of computer memory that holds data and instructions for long periods. Storage allows data to: exist even after the power to the computer has been turned off; be transported between computers; or be stored in safe locations. There are many types of storage, each with different benefits.

As computers and computer programs become increasingly sophisticated, the ability to store a lot of data in as little space possible becomes increasingly critical. So, one of the most important areas in computer technology is the area of secondary storage. Secondary storage differs from computer memory because it refers to data that is not currently being used by the computer. Secondary storage is like a book on a shelf waiting to be read. The type of storage available varies greatly in terms of the amount of data that is to be stored, what the storage medium is made from, and how fast a computer can read the information contained in storage.

Magnetic Storage

Magnetic storage media are the most common form of secondary storage. Such media include magnetic tape, floppy disks and hard disks. Magnets are an excellent way to store information because they are naturally bipolar, meaning they carry either a north or south orientation. Since computers work on a binary system, the magnet's state can easily be read by a computer as pieces of information. Early computers used a core memory consisting of iron beads that were magnetized in either a positive or negative direction. Later, magnetic tape replaced core memory. Similar to audio cassettes that play music, the magnetic tape arranges bits of data into tracks along the length of tape. A track with a positive-producing orientation charge represents a one and a track with a negative-producing orientation charge represents a zero. Originally, computer tapes were arranged on 1/2 mile spools. Cassette storage tape has become increasingly popular recently because of its ability to hold a vast amount of data in a case not much larger, although somewhat thicker, than a standard audio cassette. The amount of data a tape holds depends upon how long it is and the density of magnetic particles it contains.

Floppy disks have replaced magnetic tape as the most common storage medium, and are basically circular pieces of magnetic material that the disk drive can read very rapidly. This is because magnetic tape must physically pass a read/write head, like a viewer standing at a fixed point while watching a parade. But the disk drive can jump to any part of the floppy disk it needs. Tracks of information on a disk are divided up into concentric circles and subdivided into sectors. Often, when a new disk is inserted into a machine it must be formatted. This means that the computer needs to organize the tracks and sectors so that it has a systematized method of storing and retrieving information. Floppy disks come in two sizes: 5 1/4 inch and 3.5 inch. Because the 3.5-inch disk, also called a diskette, is smaller, comes in its own rigid protective case, and holds more data than the older 5 1/4-inch disk, it is now more common than the larger disk. High density disks hold more data, because they have more magnetized particles than regular, or double-density, disks. A standard high density 3.5-inch disk can hold up to 2 megabytes (MB) of data.

Hard disks store information in the same manner as a floppy disk . They differ from floppy disks in that hard disks are constructed of a more rigid material, like aluminum or glass (hence their name), hold more information because they use both disk sides, and are not removable, so they stay inside the computer. Usually the hard disk consists of several disks that together are able to hold more data. Read/write heads and arms skim the disk's surface to transfer data to and from it. Although the smallest hard drives start at about 40 MB, many personal computers are now offering hard drive options up to 1 gigabyte (GB).

Large computer systems naturally contain much more information than personal computers and have special hard drives to hold data. One such drive is called RAID, an acronym for Redundant Array of Inexpensive Disks. This system employs many small hard disks, over 100 in some cases, and the data is distributed among them. When data is requested from RAID, the disks share the responsibility and deliver information to the central processing unit (CPU) on different paths. This greatly increases the speed at which information is delivered. A RAID system can deliver 10 million characters to the CPU every second.

Optical Storage

A storage technology with growing importance is optical . Many people are already familiar with such storage in the form of audio compact discs, or CDs. Videodiscs are similar to audio compact disks, except they hold video information. Instead of storing music or video, however, computers use the discs to hold data that a computer can understand. This is because the secret to CDs is their ability to convert information they receive into binary digits, the language a computer speaks. A laser can be used to burn holes into the CD material. The holes make up the bits of data. Because so many of these holes can fit onto one disk, CDs have tremendous capability to store information. One compact disk can hold as much information as 330 floppy disks. Compact Disc-Read Only Memory (CD-ROM) is the most popular kind of optical storage for a CD. As its name implies, this method of storage provides information that cannot be altered. It is a good way to store a lot of information that will not change, such as encyclopedias, dictionaries and other reference works. An entire 21-volume encyclopedia can fit onto one compact disc with room to spare. Because compact discs also can contain audio or video information, these elements are often combined into multimedia discs. Encyclopedias on CD-ROM, for example, can provide a greater breadth of information than traditional print versions by employing multimedia.

Many companies, however, also need to record a great deal of information inexpensively for business purposes. Write-Once, Read Many (WORM) compact discs allow them to do so. Using special devices that record information onto a CD, for example, a company can develop a catalog of all its inventory for the last 50 years without using the space that printed volumes would require. New forms of technology, including erasable magneto-optical discs allow compact discs to be used like standard floppy disks because of their ability to replace old information with new information. This technology uses a laser to warm tiny spots on magnetic film. This, along with magnets, changes the direction of the magnetic particles, creating a binary system.

Cutting-Edge Storage Technology

New storage technology has begun to push the limits of how much can be stored in a given space as well as how that memory is used. One such technology is three-dimensional storage, or holographic memory. Also called memory cubes, the devices store information in blocks of light-sensitive crystal. Lasers stack information into two-dimensional “pages,” which then are coordinated into stacks. Not only can these devices store a tremendous amount of data, but the access speed would also far surpass conventional technology. By some estimates, it would take a memory cube one second to transfer the same amount of information it would take a magnetic disk five hours to transfer. A fully functional 3-D storage medium could be ready by the end of the century.

Other cutting-edge storage devices, however, are ready now. These devices allow more versatile and ingenious applications of information storage. Personal Computer Memory Card International Association (PCMCIA) cards are one such technology. Slightly larger than a credit card, these devices can store up to 100 MB of memory. Their small size makes them excellent for small palm-top or laptop computers. Smart cards use similar technology to store a range of information. They can hold medical histories, consumer information or other personal identification. Some public telephones and tollways use these devices as debit cards. Yet another alternative is memory buttons, small round devices that attach to virtually anything and contain about 500 characters of information. A small probe-like device allows one to add or delete information to the button. It is currently used to keep track of warehouse inventory.

Devices such as these represent just one of the multitude of various storage technologies currently available. Deciding which type of storage is appropriate for a particular need must be determined by figuring out what kind of data is to be stored, how much data there is, how long it is to be kept, its importance, and how much money one can spend on storage equipment and media.

u contributed by Christopher LaMorte

Computer Trends

Advances in digital technology have transformed the world around us. As the computer industry continues to mature, such things as voice recognition, interactive television and global communications — once only dreams — are quickly becoming reality. The following is a look at some of the services, products and technology that will shape the dynamic, interconnected universe of the future.

Interactive Services

Using digital technology and computers, television is being transformed from a one-way communication medium into a two-way system. A number of interactive television networks are currently being developed with the potential of offering services ranging from video on demand (VOD) and home shopping and banking to interactive movies and games. Already, systems such as Interactive Networks, a California-based television service, offer interactive entertainment programming through small laptop computers that exchange special FM radio signals with central computers, allowing viewers to play along with game shows, guess the outcome of sporting events, or even predict the ending of whodunit television shows.

For some time, set-top boxes have been available that allowed subscribers to order pay-per-view movies and other cable services by sending signals to the cable system's main processing center, which then responds by providing the service. However, these services pale in comparison to proposed interactive services that digital networks will offer. By combining fiber optic and coaxial cable to transmit signals, these new networks will soon have the capacity to offer an incredible array of digitized movies, music and other types of entertainment and information.

Interactive Games

Industry giants, such as Matsushita, MCA, and Time-Warner, are joining together to develop interactive video games with increasingly sophisticated sound and graphics. New gaming standards, such as 3DO, a combination of chips and specifications that developers can license, are capable of creating games with all the excitement of being inside a movie — in fact, movies are now being shot with additional footage to make them more easily transferred to 3DO and CD-ROM game formats. Some movie scripts are reviewed for their video game potential even before the film is shot.

Because most interactive games are already in digital format, they easily join the mix of services delivered to the home by interactive television networks. The Sega Channel, already available over some cable systems, offers a preview of the future by piping video games into the home through a special tuner/decoder cartridge that plugs into a Sega Genesis video game machine. Once connected to a television cable line, players can take their choice of a number of the most popular Sega games. Other interactive game systems that allow viewers to guess the moves of players in basketball games as well as the game's outcome are being developed.

Artificial Intelligence

Although scientists have yet to develop machines that can truly think, elements of artificial intelligence are today being used to develop computers that process information in seemingly human ways. Neural networks, electronic devices that mimic the neurological structure of the human brain, allow computers to learn by association and recognition rather than by being programmed. These computers also employ what is known as fuzzy logic, a type of logic that allows them to adjust what they do according to the circumstances at hand.

Graphical User Interfaces

Graphical user interfaces (GUIs)228, which facilitate visually oriented, user-friendly communications between computers and users, are today a standard feature of most computer programs and systems . Most GUIs use icons, menus, status bars or other on-screen devices to guide users as they operate their computers; however, these familiar devices are beginning to yield to newer, real world interfaces that put users inside highly realistic, often three-dimensional settings. Soon, some GUIs might resemble faces and may include speech-recognition software that would enable computers to understand a user's spoken instructions.

Voice Recognition

Improved programming languages, coupled with today's more powerful computers and more sophisticated digital signal processors, are combining to make voice recognition programs a viable choice for anyone who cannot or does not want to use a traditional keyboard and mouse . These programs range from simple ones that allow verbal notetaking to programs that can translate words into computer code, allowing users to create documents ranging from letters to spreadsheets. By the turn of the century, computers may have the capacity to recognize any person's voice.

Personal Digital Assistants (PDAs)

These small, handheld devices are gaining in popularity as many of their original problems, such as poor screen visibility, lack of speed and faulty handwriting recognition, continue to improve . Although better software has improved handwriting recognition, some PDAs now avoid the issue entirely by offering touch screens that allow users to execute commands by clicking or pressing on icons.

Ease of communications continues to be a hallmark of the PDA industry, as more refined software and better communications protocols continue to expand the ways in which PDAs can be used in the field to access information stored on remote computers as well as to communicate with on-line information services, fax machines and other hand-held devices.

Multimedia

Multimedia programs are moving well beyond the rudimentary text-and-number crunching that typified yesterday's computer programs. Sophisticated games, educational titles, and reference products that seamlessly integrate sound, video and graphics with text are increasingly luring consumers into the world of desktop interactivity. Many new computers come pre-equipped with the requisite CD-ROM drives, sound boards, video accelerators and speakers for multimedia use; these components are also available for upgrading older systems . In the future, multimedia products may be accessed through a variety of sources, including interactive television, and increasingly through such on-line services as the Internet, which currently provides multimedia applications through the World Wide Web (WWW or just Web).

The Internet

There are currently over 30 million people connected to this global network, which allows users to exchange files, send messages, download graphics and text, and share other resources. According to industry sources, the number of people using Internet resources is expected to expand to nearly 100 million by the end of the century.

Network operators continue to look for new services to put on the Internet. In the near future, users might be able to utilize the Internet for everything from ordering concert tickets to gambling at their favorite casino to taking long-distance education courses. Multimedia applications are already a big part of the World Wide Web, the newest addition to the Internet protocol system. The number and size of these applications should continue to grow as transmission speeds accelerate.

On-line Services

The world of on-line communications continues to expand as more consumers use their computer modems to join the virtual communities being created in cyberspace. How they actually join can take a variety of different forms. Local bulletin board services (BBSs) are a favorite; approximately 60,000 BBSs cater to some 18 million people in the United States. BBSs are dedicated to every topic imaginable, ranging from home improvement and repair to an on-line network for fans of the Grateful Dead.

Today there are five main commercial on-line services: America Online (AOL), Prodigy , CompuServe, GEnie, and Delphi. Each provides a range of services including bulletin boards, forum areas, limited Internet access, shareware, games, live chat rooms, and searchable on-line databases. These five services control over 95 percent of the market; however, new on-line services, such as the new service from Microsoft that will ship with the company’s Windows 95, are on the horizon, and will have a substantial impact on this dynamic industry.

u contributed by Sonia Weiss

Computers: History and Development

Nothing epitomizes modern life better than the computer. For better or worse, computers have infiltrated every aspect of our society. Today computers do much more than simply compute: supermarket scanners calculate our grocery bill while keeping store inventory; computerized telephone switching centers play traffic cop to millions of calls and keep lines of communication untangled; and automatic teller machines let us conduct banking transactions from virtually anywhere in the world. But where did all this technology come from and where is it heading? To fully understand and appreciate the impact computers have on our lives and promises they hold for the future, it is important to understand their evolution.

Early Computing Machines and Inventors

The abacus, which emerged about 5,000 years ago in Asia Minor and is still in use today, may be considered the first computer. This device allows users to make computations using a system of sliding beads arranged on a rack. Early merchants used the abacus to keep trading transactions. But as the use of paper and pencil spread, particularly in Europe, the abacus lost its importance. It took nearly 12 centuries, however, for the next significant advance in computing devices to emerge. In 1642, Blaise Pascal (1623-1662), the 18-year-old son of a French tax collector, invented what he called a numerical wheel calculator to help his father with his duties. This brass rectangular box, also called a Pascaline, used eight movable dials to add sums up to eight figures long. Pascal's device used a base of ten to accomplish this. For example, as one dial moved ten notches, or one complete revolution, it moved the next dial — which represented the ten's column — one place. When the ten's dial moved one revolution, the dial representing the hundred's place moved one notch and so on. The drawback to the Pascaline, of course, was its limitation to addition.

In 1694, a German mathematician and philosopher, Gottfried Wilhelm Leibniz (1646-1716), improved the Pascaline by creating a machine that could also multiply. Like its predecessor, Leibnitz's mechanical multiplier worked by a system of gears and dials. Partly by studying Pascal's original notes and drawings, Leibniz was able to refine his machine. The centerpiece of the machine was its stepped-drum gear design, which offered an elongated version of the simple flat gear. It wasn't until 1820, however, that mechanical calculators gained widespread use. Charles Xavier Thomas de Colmar, a Frenchman, invented a machine that could perform the four basic arithmetic functions. Colmar's mechanical calculator, the arithometer, presented a more practical approach to computing because it could add, subtract, multiply and divide. With its enhanced versatility, the arithometer was widely used up until the First World War. Although later inventors refined Colmar's calculator, together with fellow inventors Pascal and Leibniz, he helped define the age of mechanical computation.

The real beginnings of computers as we know them today, however, lay with an English mathematics professor, Charles Babbage (1791-1871) . Frustrated at the many errors he found while examining calculations for the Royal Astronomical Society, Babbage declared, I wish to God these calculations had been performed by steam! With those words, the automation of computers had begun. By 1812, Babbage noticed a natural harmony between machines and mathematics: machines were best at performing tasks repeatedly without mistake; while mathematics, particularly the production of mathematic tables, often required the simple repetition of steps. The problem centered on applying the ability of machines to the needs of mathematics. Babbage's first attempt at solving this problem was in 1822 when he proposed a machine to perform differential equations, called a Difference Engine. Powered by steam and large as a locomotive, the machine would have a stored program and could perform calculations and print the results automatically. After working on the Difference Engine for 10 years, Babbage was suddenly inspired to begin work on the first general-purpose computer, which he called the Analytical Engine. Babbage's assistant, Augusta Ada King, Countess of Lovelace (1815-1842) and daughter of English poet Lord Byron, was instrumental in the machine's design. One of the few people who understood the Engine's design as well as Babbage, she helped revise plans, secure funding from the British government, and communicate the specifics of the Analytical Engine to the public. Also, Lady Lovelace's fine understanding of the machine allowed her to create the instruction routines to be fed into the computer, making her the first female computer programmer. In the 1980's, the U.S. Defense Department named a programming language ADA in her honor.

Babbage's steam-powered Engine, although ultimately never constructed, may seem primitive by today's standards. However, it outlined the basic elements of a modern general purpose computer and was a breakthrough concept. Consisting of over 50,000 components, the basic design of the Analytical Engine included input devices in the form of perforated cards containing operating instructions and a store for memory of 1,000 numbers of up to 50 decimal digits long. It also contained a mill with a control unit that allowed processing instructions in any sequence, and output devices to produce printed results. Babbage borrowed the idea of punch cards to encode the machine's instructions from the Jacquard loom. The loom, produced in 1820 and named after its inventor, Joseph-Marie Jacquard, used punched boards that controlled the patterns to be woven.

In 1889, an American inventor, Herman Hollerith (1860-1929), also applied the Jacquard loom concept to computing . His first task was to find a faster way to compute the U.S. census. The previous census in 1880 had taken nearly seven years to count and with an expanding population, the bureau feared it would take 10 years to count the latest census. Unlike Babbage's idea of using perforated cards to instruct the machine, Hollerith's method used cards to store data information which he fed into a machine that compiled the results mechanically. Each punch on a card represented one number, and combinations of two punches represented one letter. As many as 80 variables could be stored on a single card. Instead of ten years, census takers compiled their results in just six weeks with Hollerith's machine. In addition to their speed, the punch cards served as a storage method for data and they helped reduce computational errors. Hollerith brought his punch card reader into the business world, founding Tabulating Machine Company in 1896, later to become International Business Machines (IBM) in 1924 after a series of mergers. Other companies such as Remington Rand and Burroughs also manufactured punch readers for business use. Both business and government used punch cards for data processing until the 1960's.

In the ensuing years, several engineers made other significant advances. Vannevar Bush (1890-1974) developed a calculator for solving differential equations in 1931. The machine could solve complex differential equations that had long left scientists and mathematicians baffled. The machine was cumbersome because hundreds of gears and shafts were required to represent numbers and their various relationships to each other. To eliminate this bulkiness, John V. Atanasoff (b. 1903), a professor at Iowa State College (now called Iowa State University) and his graduate student, Clifford Berry**,** envisioned an all-electronic computer that applied Boolean algebra to computer circuitry. This approach was based on the mid-19th century work of George Boole (1815-1864) who clarified the binary system of algebra, which stated that any mathematical equations could be stated simply as either true or false. By extending this concept to electronic circuits in the form of on or off, Atanasoff and Berry had developed the first all-electronic computer by 1940. Their project, however, lost its funding and their work was overshadowed by similar developments by other scientists.

Five Generations of Modern Computers

First Generation (1945-1956)

With the onset of the second World War, governments sought to develop computers to exploit their potential strategic importance. This increased funding for computer development projects hastened technical progress. By 1941 German engineer Konrad Zuse had developed a computer, the Z3, to design airplanes and missiles. The Allied forces, however, made greater strides in developing powerful computers. In 1943, the British completed a secret code-breaking computer called Colossus to decode German messages. The Colossus's impact on the development of the computer industry was rather limited for two important reasons. First, Colossus was not a general-purpose computer; it was only designed to decode secret messages. Second, the existence of the machine was kept secret until decades after the war.

American efforts produced a broader achievement. Howard H. Aiken (1900-1973), a Harvard engineer working with IBM, succeeded in producing an all-electronic calculator by 1944. The purpose of the computer was to create ballistic charts for the U.S. Navy. It was about half as long as a football field and contained about 500 miles of wiring. The Harvard-IBM Automatic Sequence Controlled Calculator, or Mark I for short, was a electronic relay computer. It used electromagnetic signals to move mechanical parts. The machine was slow (taking 3-5 seconds per calculation) and inflexible (in that sequences of calculations could not change); but it could perform basic arithmetic as well as more complex equations.

Another computer development spurred by the war was the Electronic Numerical Integrator and Computer (ENIAC), produced by a partnership between the U.S. government and the University of Pennsylvania , 70,000 resistors and 5 million soldered joints, the computer was such a massive piece of machinery that it consumed 160 kilowatts of electrical power, enough energy to dim the lights in an entire section of Philadelphia. Developed by John Presper Eckert (1919-1995) and John W. Mauchly (1907-1980), ENIAC, unlike the Colossus and Mark I, was a general-purpose computer that computed at speeds 1,000 times faster than Mark I.

In the mid-1940's John von Neumann (1903-1957) joined the University of Pennsylvania team, initiating concepts in computer design that remained central to computer engineering for the next 40 years. Von Neumann designed the Electronic Discrete Variable Automatic Computer (EDVAC) in 1945 with a memory to hold both a stored program as well as data. This stored memory technique as well as the conditional control transfer, that allowed the computer to be stopped at any point and then resumed, allowed for greater versatility in computer programming. The key element to the von Neumann architecture was the central processing unit, which allowed all computer functions to be coordinated through a single source. In 1951, the UNIVAC I (Universal Automatic Computer), built by Remington Rand, became one of the first commercially available computers to take advantage of these advances. Both the U.S. Census Bureau and General Electric owned UNIVACs. One of UNIVAC's impressive early achievements was predicting the winner of the 1952 presidential election, Dwight D. Eisenhower.

First generation computers were characterized by the fact that operating instructions were made-to-order for the specific task for which the computer was to be used. Each computer had a different binary-coded program called a machine language that told it how to operate. This made the computer difficult to program and limited its versatility and speed. Other distinctive features of first generation computers were the use of vacuum tubes (responsible for their breathtaking size) and magnetic drums for data storage.

Second Generation Computers (1956-1963)

By 1948, the invention of the transistor greatly changed the computer's development . The transistor replaced the large, cumbersome vacuum tube in televisions, radios and computers. As a result, the size of electronic machinery has been shrinking ever since. The transistor was at work in the computer by 1956. Coupled with early advances in magnetic-core memory, transistors led to second generation computers that were smaller, faster, more reliable and more energy-efficient than their predecessors. The first large-scale machines to take advantage of this transistor technology were early supercomputers, Stretch by IBM and LARC by Sperry-Rand. These computers, both developed for atomic energy laboratories, could handle an enormous amount of data, a capability much in demand by atomic scientists. The machines were costly, however, and tended to be too powerful for the business sector's computing needs, thereby limiting their attractiveness. Only two LARCs were ever installed: one in the Lawrence Radiation Labs in Livermore, California, for which the computer was named (Livermore Atomic Research Computer) and the other at the U.S. Navy Research and Development Center in Washington, D.C. Second generation computers replaced machine language with assembly language, allowing abbreviated programming codes to replace long, difficult binary codes.

Throughout the early 1960's, there were a number of commercially successful second generation computers used in business, universities, and government from companies such as Burroughs, Control Data, Honeywell, IBM, Sperry-Rand, and others. These second generation computers were also of solid state design, and contained transistors in place of vacuum tubes. They also contained all the components we associate with the modern day computer: printers, tape storage, disk storage, memory, operating systems, and stored programs. One important example was the IBM 1401, which was universally accepted throughout industry, and is considered by many to be the Model T of the computer industry. By 1965, most large business routinely processed financial information using second generation computers.

It was the stored program and programming language that gave computers the flexibility to finally be cost effective and productive for business use. The stored program concept meant that instructions to run a computer for a specific function (known as a program) were held inside the computer's memory, and could quickly be replaced by a different set of instructions for a different function. A computer could print customer invoices and minutes later design products or calculate paychecks. More sophisticated high-level languages such as COBOL (Common Business-Oriented Language) and FORTRAN (Formula Translator) came into common use during this time, and have expanded to the current day. These languages replaced cryptic binary machine code with words, sentences, and mathematical formulas, making it much easier to program a computer. New types of careers (programmer, analyst, and computer systems expert) and the entire software industry began with second generation computers.

Third Generation Computers (1964-1971)

Though transistors were clearly an improvement over the vacuum tube, they still generated a great deal of heat, which damaged the computer's sensitive internal parts. The quartz rock eliminated this problem. Jack Kilby, an engineer with Texas Instruments, developed the integrated circuit (IC) in 1959. The IC combined three electronic components onto a small silicon disc, which was made from quartz. Scientists later managed to fit even more components on a single chip, called a semiconductor. As a result, computers became ever smaller as more components were squeezed onto the chip . Another third-generation development included the use of an operating system that allowed machines to run many different programs at once with a central program that monitored and coordinated the computer's memory.

Fourth Generation (1971-Present)

After the integrated circuits, the only place to go was down — in size, that is. Large scale integration (LSI) could fit hundreds of components onto one chip. By the 1980's, very large scale integration (VLSI) squeezed hundreds of thousands of components onto a chip. Ultra-large scale integration (ULSI) increased that number into the millions. The ability to fit so much onto an area about half the size of a U.S. dime helped diminish the size and price of computers. It also increased their power, efficiency and reliability. The Intel 4004 chip, developed in 1971, took the integrated circuit one step further by locating all the components of a computer (central processing unit, memory, and input and output controls) on a minuscule chip. Whereas previously the integrated circuit had had to be manufactured to fit a special purpose, now one microprocessor could be manufactured and then programmed to meet any number of demands. Soon everyday household items such as microwave ovens, television sets and automobiles with electronic fuel injection incorporated microprocessors.

Such condensed power allowed everyday people to harness a computer's power. They were no longer developed exclusively for large business or government contracts. By the mid-1970's, computer manufacturers sought to bring computers to general consumers. These minicomputers came complete with user-friendly software packages that offered even non-technical users an array of applications, most popularly word processing and spreadsheet programs. Pioneers in this field were Commodore, Radio Shack and Apple Computers. In the early 1980's, arcade video games such as *Pac Man* and home video game systems such as the Atari 2600 ignited consumer interest for more sophisticated, programmable home computers.

In 1981, IBM introduced its personal computer (PC) for use in the home, office and schools. The 1980's saw an expansion in computer use in all three arenas as clones of the IBM PC made the personal computer even more affordable. The number of personal computers in use more than doubled from 2 million in 1981 to 5.5 million in 1982. Ten years later, 65 million PCs were being used. Computers continued their trend toward a smaller size, working their way down from desktop to laptop computers (which could fit inside a briefcase) to palmtop (able to fit inside a breast pocket). In direct competition with IBM's PC was Apple's Macintosh line, introduced in 1984. Notable for its user-friendly design, the Macintosh offered an operating system that allowed users to move screen icons instead of typing instructions. Users controlled the screen cursor using a mouse, a device that mimicked the movement of one's hand on the computer screen.

As computers became more widespread in the workplace, new ways to harness their potential developed. As smaller computers became more powerful, they could be linked together, or networked, to share memory space, software, information and communicate with each other. As opposed to a mainframe computer, which was one powerful computer that shared time with many terminals for many applications, networked computers allowed individual computers to form electronic co-ops. Using either direct wiring, called a Local Area Network (LAN), or telephone lines, these networks could reach enormous proportions. A global web of computer circuitry, the Internet, for example, links computers worldwide into a single network of information. During the 1992 U.S. presidential election, vice-presidential candidate Al Gore promised to make the development of this so-called information superhighway an administrative priority. Though the possibilities envisioned by Gore and others for such a large network are often years (if not decades) away from realization, the most popular use today for computer networks such as the Internet is electronic mail, or E-mail, which allows users to type in a computer address and send messages through networked terminals across the office or across the world.

Fifth Generation (Present and Beyond)

Defining the fifth generation of computers is somewhat difficult because the field is in its infancy. The most famous example of a fifth generation computer is the fictional HAL9000 from Arthur C. Clarke's novel, *2001: A Space Odyssey* .HAL performed all of the functions currently envisioned for real-life fifth generation computers. With artificial intelligence, HAL could reason well enough to hold conversations with its human operators, use visual input, and learn from its own experiences. (Unfortunately, HAL was a little too human and had a psychotic breakdown, commandeering a spaceship and killing most humans on board.)

Though the wayward HAL9000 may be far from the reach of real-life computer designers, many of its functions are not. Using recent engineering advances, computers may be able to accept spoken word instructions and imitate human reasoning. The ability to translate a foreign language is also a major goal of fifth generation computers. This feat seemed a simple objective at first, but appeared much more difficult when programmers realized that human understanding relies as much on context and meaning as it does on the simple translation of words.

Many advances in the science of computer design and technology are coming together to enable the creation of fifth-generation computers. Two such engineering advances are parallel processing, which replaces von Neumann's single central processing unit design with a system harnessing the power of many CPUs to work as one. Another advance is superconductor technology, which allows the flow of electricity with little or no resistance, greatly improving the speed of information flow. Computers today have some attributes of fifth generation computers. For example, expert systems assist doctors in making diagnoses by applying the problem-solving steps a doctor might use in assessing a patient's needs. It will take several more years of development before expert systems are in widespread use.

u contributed by Christopher LaMorte with John Lilly

Baudot, Jean-Maurice-Emile (1845 – 1903)

French engineer who devised a telegraph code that became the most commonly used telegraphic alphabet by the mid-20th century, and who also invented a multiplex system. The information technology term *baud* is based on his name.

Emile Baudot was born in Magneux, France, in 1845. At the age of 29, he obtained a patent on a telegraph code that largely replaced the Morse system over the coming decades. The Baudot Code was more economical than Morse's, using a five-unit combination of current-on or current-off signals of equal duration as opposed to Morse's short dots and long dashes. Baudot's system provided for 32 permutations, more efficiently covering the Roman alphabet, punctuation signs, and the machine's mechanical functions.

In 1894 Emile Baudot also invented a multiplex system, which transmitted several telegraphic messages simultaneously on the same channel or circuit. Nine years later, he died in Sceaux, France, at age 58. The term *baud*, meaning the number of times per second that switching can occur in a communications channel, is derived from his name.

u contributed by Kay S. Volkema

Computers: How They Work

At its most basic level, a computer has three major functions: to accept input, to process it and produce an output. It does this by converting data into electrical signals. Though it only has two signals available to it, on and off, a computer is able to process a mind-boggling amount of data at an equally tremendous rate.

Analog Vs. Digital Computers
When we think of a computer, we most likely think of the electronic device that helps us write letters or create spreadsheets. Actually, that is only one type of computer, called a digital computer. The other type of computer, called the analog computer, pre-dates its digital cousin and performs quite differently from it. An analog computer uses a constantly changing physical force as input. For example, the slide rule — a type of analog computer — accepts input in the form of a movable scale. In terms of electronic computing, constantly varying voltage levels are used as input to produce an output that could be read as data. The output was a line traced on a piece of paper. The Differential Analyzer, used for solving differential equations in the 1930's, is one example of an analog computer.

The digital computer, by contrast, uses only two voltage levels: on and off. A modern computer has millions of electronic circuits that contain these on/off states. By a process called digitization, information can be represented by combinations of these on-off signals. Any type of data, whether music, numbers, pictures or sounds, can be digitized and stored in computer circuitry.

Computer Speed
Because a digital computer is able to process these on-off signals so rapidly, it has enormous power. The faster a computer can check its circuits, which contain the on-off signals, the more power it has. These circuit-checking cycles are so quick they are measured in megahertz (MHz), one of which equals a million cycles per second. Most personal computers manufactured today complete at least 33 to 66 million cycles per second. Manufacturers have been able to double computer clock rates roughly every two years.

Computers have clocks that set the cycle pace. The amount of data the computer picks up during each cycle is increased even further because instead of understanding one binary digit at a time, many digits are linked together. One on-off combination is called a bit (binary digit). In the United States, eight bits equals one byte. One byte contains enough possible on-off combinations to represent every letter, number and character on a standard keyboard. Some computers contain a 32-bit microprocessor, which can handle up to 32 bits of data at one time.

Basic Elements of a Computer

The Central Processing Unit (Microprocessor*)*
Sometimes people refer to the central processing unit (CPU) as the computer's heart. But really, it is the brain. Like the human brain, the CPU or microprocessor is the most vital

organ. In combination with operating system software, it controls and coordinates other parts of the computer, it calculates and “thinks about” data input, and temporarily stores data in memory.

The Arithmetic/Logic Unit (ALU)

This part of the computer does the hard thinking. It performs arithmetic and logical operations. Though the ALU can perform all the basic arithmetic functions, it always does so through addition. This may sound strange, but it works. For instance, to subtract numbers, the ALU adds negative numbers (-2 + -2 = -4); to multiply, it adds successively (2 X 3 = 2 + 2 + 2); and to divide, it repeats negative addition until it reaches zero and then counts how many tries it took to get there (8/4 = 8 + (-4) + (-4) = 0; 2 = number of tries to reach zero). The logic portion of the ALU compares values and makes judgments based on their comparative value by using IF, AND and OR statements.

Primary Storage (Registers)

The computer keeps track of numbers, data, or instructions that the CPU processes by placing them in primary storage locations called registers. Registers act like electronic “sticky notes,” because the computer uses them to jot down incoming instructions or data. After the CPU processes this transient data contained in registers, it disposes of the data. This disposal gives the register space to hold new data.

The Control Unit

The control unit allows all of the CPU functions to work together. It interprets data coming into the CPU and tells the computer what that data means. It also regulates the flow of information into the CPU and coordinates its internal functions, allowing it to work efficiently.

Bus

Though not a part of the central processing unit, the bus is important in understanding how the computer processes information. The bus is the computer’s internal data transportation system. Various bus wires are used to move different types of data to the areas they are needed. For instance, a data bus moves data from places where it is stored (called a memory location) to the central processing unit. An address bus is used to identify memory address locations (the places where data bits are stored) so the computer can keep track of information. The control bus carries signals that the control unit produces. The bus also moves data between the CPU and various computer components so the CPU knows what is happening with the rest of the computer. The wider a bus is, the more information it can provide to the CPU at one time. By transporting more bits of data to the CPU, a wide bus enables a computer to operate more quickly. Therefore, bus width — measured by how many bits of data it transports at one time — is important in determining how fast a computer processes information.

Software

To be useful, computers must be programmed with instructions that tell them how to behave. These sets of instructions are referred to as programs. They are also known as software or applications. There are two broad categories of software: operating systems and application software.

Operating Systems

Operating systems coordinate all the essential components of a computer like input, processing and output. Most computers come with operating system software already installed. An operating system structures the computer's working environment. For example, the disk operating system (DOS), which is used with many IBM-compatible computers, provides the instructions that tell the computer how to function. A computer running DOS accepts input in the form of commands that must be typed by the user.

Macintosh computers, on the other hand, look and perform quite differently from DOS operating systems because their operating software tells them to behave in a distinct way. Unlike DOS, the Macintosh operating system offers a graphical user interface (GUI). Instead of typing instructions on a keyboard, users manipulate a device called a mouse to move an on-screen pointer to select small pictures (called icons) on the screen. By selecting specific icons, users can perform certain tasks, such as starting a program. Windows, a popular GUI program for IBM-compatible computers, allows DOS to operate with graphical elements as well.

Some operating systems can be used on a variety of computers. UNIX, for example, can be used on small personal computers, mid-sized computers or large mainframe or supercomputers. It is often used by large institutions, such as universities, with complex computing needs.

Application Software

Although a computer's hardware capabilities, such as clock speed, memory size and bus width, are important factors in determining its usefulness, most benefits we receive from computers are tied to their ability to run application software, also called programs. In fact, this type of software is so crucial that consumers often buy computers based primarily on what programs the computer can run. There are different categories of application software, each developed for a special purpose. The range of computer programs is broad. A few of the most popular types of application programs for the non-technical computer user include:

u *Word processing*. These popular programs enable users to type material, such as letters or reports, then edit and format it on the screen. Because word processing programs allow users to easily manipulate and change text before printing a document and since they offer a great range of format options (such as choosing what the typeface looks like and how big it is), using a word processing program is often much more challenging than using a typewriter to produce a document.

u *Desktop publishing programs (DTPs).* In a sense, these programs take word processing one step further because they allow users to create entire publications complete with a unique layout and design. These layouts can include pictures, graphics, columns and many other elements. Most newspapers and magazines design their layouts using desktop publishing programs. The growth in special-interest newsletters is largely due to the availability of desktop publishing programs.

u *Spreadsheets*. These programs are used to organize numbers and perform mathematical calculations. They are particularly useful when calculating long lists of numbers, which most people find tedious. Also, by changing inputs, users can immediately observe the impact the change has on the overall spreadsheet. This selective number manipulation is called "what if analysis."

u *Database programs*. These programs are useful in a broad range of areas. Basically, they organize and manage a large group of data. Data may consist of numbers, addresses,

letters, files or any other type of information a computer stores.
u *Games*. These programs are written for education or enjoyment. They sometimes are computerized versions of old favorites like chess or solitaire. Other times, the games can only be found on computers. These might include complex fantasy games that create virtual “worlds” that exist only in software. “Edutainment” games blend entertainment with education and encourage computer players to learn through game playing. For instance, players may score points by providing correct answers to math or spelling problems.

Programming Languages

Though some computers can be manufactured to understand specific spoken instructions, none are able to understand conversational language. Human languages are filled with ambiguities that present-day computers cannot fathom. Therefore, a computer understands instructions through specialized languages developed specifically for it. Computer languages have advanced as computers themselves have improved. Early computer programmers wrote programs in machine language, a type of language in which instructions were hard-coded into the computer’s circuitry. Soon programmers developed languages that consisted of specialized codes that generated specific machine language instructions. These early languages were quite user-unfriendly and made sense only to computers and their programmers. Later, languages used common English words like “read,” “write,” and “end.” These languages are known as high-level languages. Early high-level programming languages include BASIC (Beginners All-Purpose Instruction Code), which is often used to teach principles of programming, and FORTRAN (Formula Translator), which at one time was common in the science and math disciplines. Today many programs are written in the C or C++ computer language.

C++ is an object-oriented programming language, a type of program that has become increasingly popular. Instead of writing programming code in a rigidly linear fashion, object-oriented programs group functional pieces of code into modules called “objects.” The objects are linked to each other and can be reused in different parts of a program or in different programs.

Though some people have found object-oriented languages difficult to learn, the programs are beneficial because they can save time during the programming process. For example, a software application, such as a desktop publishing program or a word processing program, may contain several million lines of instruction code. The sheer length of a program like this makes it expensive and time consuming to create, thus generating a need for more efficient types of languages like object-oriented programming.

Computer Viruses

Some computer programs, called viruses, are specifically created to be destructive to other programs. Computer viruses are programs designed to interfere with applications or with a computer’s operating system. They are called viruses because, like the human variety, a computer must come into contact with another computer that contains the virus program for the first computer to become infected. Computers come “into contact” with each other through telephone connections (for example, when downloading materials from an electronic bulletin board) or by using materials on floppy disks that have been infected through use with another, virus-carrying computer. The damage these software “germs” cause varies. Sometimes virus creators are desperately seeking attention so the virus simply displays a random, yet irritating, message on the screen. The other end of the spectrum includes virus strains created by social malcontents who have developed viruses that can cause severe damage to millions of computers. There are several reliable computer programs called virus detection software, however, that can search for and destroy the more common computer viruses. It is difficult, though, for anti-virus programmers to keep up with the new and increasingly complex viruses created every day.

Memory and Data Storage

Although the CPU does the computer's thinking, it is unable to remember anything on its own. Computers must use other devices to help them store data and instructions that are processed by the CPU. The amount and type of memory a computer has is important, because memory size determines what kind of programs the computer can run, how many programs it can run at one time, and how much data those programs can contain. The size of a computer's memory is usually measured in kilobytes or megabytes. One byte could equal one typed character or space. One kilobyte equals 1,024 bytes. A megabyte (MB) equals one million bytes. To put this in perspective, a one-page word processing document without any graphical elements usually contains about three to four kilobytes dedicated for memory space of text information. So, a computer with 4MB of memory has enough room for more than four million characters, or roughly 1,200 pages of written text. There are different types of memory that the computer uses, depending upon how the operator intends to use the data and how long it will be stored.

Read Only Memory (ROM)

Read Only Memory (ROM) is a kind of memory that has been manufactured with a permanent set of instructions or data that the user cannot alter. For example, the computer's basic input/output system (BIOS), part of a computer's operating system, is programmed into ROM chips. The BIOS also checks the computer's components when the power is turned on to make sure everything is working properly. Video game cartridges, such as those for Nintendo game systems, also contain ROM chips that contain the game program.

Another popular ROM format is the CD-ROM, which stores instructions and data on a compact disc (CD). Audio CDs and their video counterpart, the laser disc, contain audio and visual information that has been digitized — converted into arrangements of ones and zeroes. Machines like computers or CD players understand how to reconstruct those arrangements into forms humans can deal with, such as sound or pictures. Because compact discs and laser discs contain so much information (in excess of 600 MB) and cannot be altered by the user, they are excellent ways to store large amounts of data such as complex video games, music, movies, and encyclopedias.

Random Access Memory (RAM)

Unlike ROM, Random Access Memory (RAM) is only temporary storage. Once the computer power is switched off, the contents of RAM are erased. Because of its fleeting nature, RAM is often referred to as volatile memory. But RAM also differs from ROM because new instructions or data can be entered into RAM as well as read from it. RAM provides the high-speed memory your computer needs to run software programs.

When people use a program, such as a spreadsheet or word processing program, they are using the RAM storage to hold much of the data until they save it in a more secure place. That is why computer users are warned to save their work frequently. A power outage or an accidental power disconnection could be devastating to a user with a lot of information in RAM. Different types of programs use different amounts of RAM. Data-intensive programs, such as desktop publishing programs, require a great deal of RAM to keep them running quickly. Today, computer manufacturers produce computers with a range of RAM sizes, usually starting around 2 to 4MB. More advanced computers designed to handle audio-visual data or to run several programs at once can contain 8, 12, 16 MB or more of RAM. Computers designed for business applications may contain hundreds of megabytes of RAM. A computer's price usually increases with the amount of RAM it has.

External Storage Devices

Punch Cards and Magnetic Tape

Although RAM and ROM are helpful in dealing with immediate memory or permanent memory, a middle ground is needed that allows users to store data that can be altered later or kept for long periods. When working on a lengthy spreadsheet, for instance, a user may work on it for several days in a row. So users need a way to store the information they have already entered into the document, yet still be able to return and alter it by adding more information or changing the data. Early computers used punch cards to store computer programs and data. The computer read instructions and data through a series of punched holes on small cards, or sometimes long strips of paper tape.

Modern computers provide many methods of storing data, usually by means of magnetic storage media. This is similar to the technology that records music onto tape cassettes, except instead of recording analog signals, computers store digital information. Magnetic media is useful because magnets have natural positive and negative poles, which create a binary system that the computer can easily understand. By arranging data bits into either a negative or positive direction, the computer's drive (the device that reads the magnetic media) can translate that positive or negative direction into either a one or a zero.

One type of magnetic storage, primarily used in larger computers, is magnetic tape. Magnetic tape comes in extremely long spools (one-half mile in some cases) and is capable of storing vast amounts of data. In contrast, early home computers, such as the Commodore 64, used a cassette drive that used standard audio cassettes to record information. High-speed tape cartridges, a relatively new medium that looks similar to standard audio cassettes (though somewhat thicker) have gained a foothold in mass data storage. Despite their physical similarity to audio cassettes, this new type of tape cartridge is able to contain as much information as the old, one-half mile magnetic tape spool.

Disks

The development of magnetic disks in the 1970's meant the decline of the audio cassette tape for home computer data storage. Instead of arranging information sequentially on a long, thin tape (which may take the computer a relatively long time to read), a flat circular disk of magnetically coated material is used to store data. A personal computer usually has at least two disk drives. One, called the hard drive, is usually permanently installed in the computer. The other, called the floppy drive, reads disks that can be inserted into and removed from the machine. Floppy disks also allow information to be transported between computers, provided that the computers are compatible.

The hard disk usually has much more storage capacity than the floppy disk and so is generally used as the main storage area. Today, standard hard drives for personal computers start at around 40 or 80 megabytes and are available with storage up to 1 gigabyte (1 billion bytes) or more. Forty megabytes can store about 40,000 pages of text. But a floppy disk, depending on what type of disk it is, usually can store about 1.5 megabytes of data. This means that application software programs, such as word processing programs, may come on several disks, each of which must be downloaded onto the computer's hard drive before the program can be used.

Other Storage Media

Though various magnetic storage media offer the most common and cost-efficient methods of storing data, alternative methods exist. For example, the write-once, read-many (WORM) optical drive allows information to be written onto an optical medium. This is, however, a slow and expensive storage method, used mainly by those who need to store a great amount of data, such as drafting plans.

Input/Output Devices

A computer must have ways to accept input as well as produce an output in order for people to harness the computer's ability. Input and output devices allow computers to do this by serving as the computer's eyes, ears and mouth.

Input

Input devices allow users to talk to the computer. The most common way we do this is through the keyboard. By typing messages into the computer in the form of commands or as data for it to display, we can communicate with it. Early computers received their instructions through punch cards**,** which were also used to store data. Today, the mouse represents another kind of input device. It enables users to move a pointer anywhere on the screen or to select screen icons to execute commands. Sometimes special screens, called touch screens, are used as input devices. When the user touches certain parts of the screen, the computer receives a message. Touch screen computers are used for specialized purposes rather than for general computing needs. Because touch screens are easy to understand and to use, they are often used in information centers called kiosks that are found in public areas such as airports or civic centers.

Light pens are another type of input device. By aiming a concentrated point of light onto a screen, the computer receives an instruction. Similarly, video games sometime apply this principle with "laser" guns that interact with the game's action on the screen. Optical scanners are yet another type of input device. The most familiar type of optical scanners is found at supermarket check-out aisles. Scanners take information from one medium, such as a photograph or a bar-code label, and convert it into digital information that the computer understands. Scanners are particularly useful in importing graphic images into desktop publishing programs or to input data quickly.

For video and computer game aficionados, perhaps the most enjoyable input device is the joystick , which provides users with a range of motion when playing video games. And for those who are typing-impaired, voice recognition systems understand specific spoken commands as input.

Output

Output devices allow the computer to provide its user with information. The most common output device is the video display terminal (VDT) or monitor, which enables the computer to display its work on a screen. Another output method is the printer. It can produce a “hard copy” of what the computer has displayed on the screen, of selected data, or of an entire document. Computers equipped with sound cards and speakers produce sound output. Optical disc drives can produce output by playing audio or video CDs. In addition, voice synthesizers and sound cards let the computer communicate with users through synthesized speech or audio cues.

Modems

The modem (modulator/demodulator) functions as both an input and output device. It allows the computer to use phone lines to share information with other computers by converting digital signals into analog signals and vice versa. When the modem sends information, it acts as an output device, but when it receives incoming information, it acts as an input device. Just as with human communication, the modem’s importance is found in its ability to “talk” as well as “listen.” Unlike humans, however, today’s modems do both at the same time.

Modems have spurred an interest in on-line services that allow computer users access to a great range of services such as the ability to conduct home banking or to meet other computer users across the world. These types of computer-based services, though quite sophisticated are becoming increasingly commonplace.

u contributed by Christopher LaMorte

Computer Industry

In the past 40 years, advances in digital technology have transformed the ways in which we work, how we communicate, and how we entertain ourselves. Today, we are surrounded by a dynamic, interactive, interconnected world that once existed only in the realm of science fiction. At our fingertips, in our offices and increasingly in our homes are sophisticated computers capable of communicating with networks the world over, of playing the newest interactive CD-ROM titles, of creating multimedia documents rich with graphics, sound, and color.

Larger, more powerful versions of those same computers are being combined with digital compression technologies and high-capacity cable networks to develop and deliver such eagerly anticipated services as video on demand and interactive television. Their smaller cousins, ranging in size from laptop systems to tiny hand-held devices, enable more flexible and portable computing than ever before. The operating systems and processors used to power these systems are increasingly being used to develop new products that fall somewhere between the traditional boundaries of telephones, television and computer technologies as the lines between digital industries continue to blur.

We are increasingly surrounded by a digital world, shaped by this ongoing (some call it inevitable) convergence of the computer, communications and media industries. Driven by such advances in digital technology as high-speed computer graphics chips, digital compression and fiber-optic cable, these industries have come together to create a host of new hardware and software products, as well as the networks necessary to employ them, enabling better, more powerful ways to conduct business, more ways in which to communicate and more entertainment options than ever before.

The computer industry, because it creates products that both enable the development of new technology as well as the deployment of it, is a key player in the convergence arena. The insatiable demand for new information age technology and products is creating unheard-of levels of growth and change in an industry long noted for both. Established industry leaders as well as start-up companies are playing major roles in developing new products to meet the needs of these ever-increasing audiences. They are also joining forces with other technologies as never before to help develop the hardware and software that will continue to shape the new digital universe.

New needs creating new systems
As the needs of both business and home users become more sophisticated, there is increased demand for faster, more powerful hardware and software products. Today, users in both arenas have access to computer systems with powerful microprocessors and vast storage capabilities, capable of running the largest multimedia documents or the most complex desktop publishing software. The capacity of semiconductor memory chips continues to multiply every few years, enabling the development of increasingly faster, more powerful computers. As their power goes up, their prices come down. CD-ROMs for both educational and entertainment purposes make ample use of animation as well as three-dimensional special effects, requiring fast processing speeds, powerful modems, and sophisticated sound. With the cost of microprocessors continuing to drop, fast

machines are also becoming the home user's machine. Once-costly systems with Pentium or 586 microprocessors are increasingly becoming the minimum configuration for anyone wanting to run memory-intensive multimedia titles.

Although the hot new area of interactive entertainment and information services, including video on demand (VOD) and interactive television (IT), is spurring tremendous development activity in the computer industry and great anticipation on the part of potential users, most consumers are at least several years away from feeling the broad impact of this activity as the servers and networks needed to deliver interactive technology continue to expand and be refined. What we will see from these efforts will primarily appear on our desktops, as the high costs of developing interactive products drive developers to focus the bulk of their efforts on applications for desktop computers, and desktop computers become more capable of running them.

For business users, continued improvements in microprocessor performance are making possible the use of smaller machines instead of large, cumbersome mainframes for even the largest applications. Today, over 40 percent of office PCs are connected to a local area network (LAN), and almost all workstations are networked as well. Today's improved networking hardware and software is enabling the continued coupling of these small, powerful machines, often at multiple sites, at a fraction of the cost of yesterday's mainframe-based systems. These new computing networks will make mainframes and minicomputers almost obsolete as the computing power of one machine at one site is replaced with the almost infinite power available at one or multiple sites.

Networking and internetworking
The resources available at sites around the world form the basis of the continually expanding system of networks and internetworks that are at the core of today's digital universe. An estimated 25 million computers are currently connected to on-line services such as the Internet, CompuServe, Prodigy, and America Online; significant increases in the number of computers connected to on-line services are expected as the technology necessary to connect continues to decrease in cost and become more powerful.

The wealth of available on-line resources is making networking a crucial feature for today's computers. And computers are being connected together as never before with faster and more powerful networking technology, including better cable for local and wide area networks, faster modems, and improved data transmission technologies. The number of computers joined to networks will continue to grow as new, wireless LANs make local networks more versatile than ever before. And these networks will continue to become connected, forming internetworks, linked by wired and wireless high-powered communications networks capable of transmitting large multimedia files.

Easier to use
Today's computer user wants faster, more powerful systems. But we also want systems that are easy to use. The computer industry has responded to these demands by developing software and hardware products that are more user friendly than ever before.

The applications and systems software in use today are increasingly more powerful, as well as more intuitive and user friendly. Microsoft Windows, the graphical user interface (GUI) that is still a favorite of many personal computer users, has recently taken on a number of new personas. Now there are versions of Windows for workgroups as well as for home users, and a version of Windows is being developed using object-oriented programming, a modular programming method that promises to make Windows even more versatile. Now, new applications like Microsoft's "Bob" are making computing even easier by adding a home computing arena that sits on top of Windows, offering eight helpful applications for home users as well as an animated guide to assist them. New programming methods are making word processing, data processing, and accounting software easier to use and more intuitive as well. Software agents, intuitive little programs designed to make computing easier, will soon become common components in many software packages.

New input technologies are making computer systems easier to use as well. Optical character recognition (OCR), which uses software and hardware to visually scan the characters in a document and convert them into data that can be stored in a computer, is sometimes used to eliminate the need for keying in information. Voice recognition, in existence since the mid-1980's, is improving to the point where it is being offered on many new multimedia computer systems. Handwriting recognition, an important feature on handheld personal digital assistants (PDAs), is still not as advanced as many users would like, but is steadily improving as the software that enables handwriting recognition continues to evolve.

More compatibility

The personal computer industry has long been dominated by two hardware platforms. There were personal computers that used some form of DOS or OS/2 for their operating systems, and computers from Apple Computers, Inc., which used Apple's proprietary operating system.

For years, this meant that software designed for one system could not be used on another. Today, however, the lines between these systems are beginning to blur as new alliances are being forged between their manufacturers. For example, the PowerPC chip, manufactured by IBM and Motorola, is being used in new machines manufactured by both IBM and Apple. Apple is now also allowing its once-proprietary systems to be used by other computer manufacturers, which will generate a whole new breed of Macintosh clones.

Over the years, the computer industry has moved from a primarily closed system to open architecture and standards. This shift will continue to promote competition, quicker innovation, healthier industries and more diverse technology.

More versatile, portable

Faster, smaller, and more powerful — these words have been the cornerstones of the computer industry from the beginning. Today, we not only demand power and speed, but we also demand systems that are easier to use, more flexible and more portable than ever before. This will cause computers to continue to shrink in size and grow in capacity.

Today, laptop computers are being manufactured with the flexibility to allow them to be used for both portable and desktop work. Instead of a laptop, home computer, and a multitude of remote business machines, the solution is increasingly becoming one machine equipped with such features as keyboard and mouse ports, large disk storage and enhanced video capabilities. On the road, these laptops function as fully configured, self-contained systems. At home, they function as the central processing unit (CPU) for a desktop system when connected to a mouse, an extended keyboard and an enhanced video display.

Although hand-held computers, or personal digital assistants (PDAs) have met with mixed success, the effort to refine these small devices will continue as the ways in which they can be used continue to grow. Their “plug-and-play” capability can allow physicians bed-side access to patient records and pharmacy databases through easily inserted networking cards. Notes can be entered either through a touchscreen or on a small keyboard. Information can be transmitted through a built-in fax modem or by a plug-in fax card. These small, hand-held devices can be linked to desktop computers as well by using PC cards with networking capabilities.

What the future holds

The transformation of our society is bound to continue as digital technology becomes increasingly more sophisticated and powerful. The computer industry, always a key player in the advance of such technology, will maintain its vital role in this transformation as digital technologies and industries continue to converge in their efforts to create the powerful communications, business and entertainment systems and tools of the future.

u contributed by Sonia Weiss

Computer Networks

A combination of hardware, software and connections that allow individual computers to communicate with each other and share common resources, such as files, software, hardware peripherals, and electronic mail (E-mail).

Networks may also protect shared data from some mistakes made by any one individual on the system and make sure that data is transmitted correctly. Since the first computer networks debuted in the late 1960's, they have had a great impact on the way information is distributed. Networks allow computer users access to resources found on other systems. These include files, software programs, and external hardware (modems, CD-ROM drives, scanners, etc.).

Early Computer Networks
Computer networks grew into great popularity after the development of the personal computer (PC). Originally, companies used large, highly specialized mainframe computers to control the day-to-day functions of their organizations. Although these early systems had computer networks, much of the network was limited to a single organization or firm. As PCs became capable of handling more complex tasks, their use grew. Managers used them to design spreadsheets and determine departmental goals; secretaries used them for memos, correspondence, and information management. Sometimes users needed to connect to each other or the company's mainframe or minicomputer. They needed to share common files, and the easiest way to do this was electronically. Enter the modern computer network.

Network Switching
Networks must work in many different business environments. To solve this dilemma, a number of kinds of networks have evolved. While each network type has its own set of physical characteristics, information is sent through them in one of two ways: by packet switching or circuit switching.

In packet switching, the network breaks down the data to be transmitted into small chunks called packets. These packets, which contain the information to be sent as well as directions for reaching the destination, may be transferred through the network. Almost any terminal or peripheral (printer, server, etc.) on the link can receive the data.

Circuit switching connects any two nodes on the network directly. There is one central switch to which all devices connect. Information can go from one computer device to another through the point-to-point connection.

Kinds of Networks
The optimal size and speed of a network depends on the number of users who may need access to resources. Wide area networks (WANs) connect users spread over great distances. By using packet switching technology, WANs can transmit information over a variety of connectors, including phone lines, fiber optic cables, microwave transmitters, and satellites. Often they operate at very high speeds with low transmission error rates. Users connect to the network through a modem or high speed digital service like

integrated services digital network (ISDN). Examples of WANs include corporate networks, the Internet, value added networks (VANs) and the networks provided by long-distance telephone service companies.

Metropolitan area networks (MANs) cover a smaller geographic area than WANs. This type of network usually connects users in a county, city or community. Most MANs use data lines and fiber optic cables to connect multiple users to a single host computer or to a computer network. MANs are usually run by a single supplier or carrier.

Local area networks (LANs) are often found in businesses. Originally, they connected users in a limited area, usually in a building or group of buildings. Today, LAN users often belong to a single organization or business and can exist in a limited or national geographic area. Stations on the network are connected to each other directly or go through a connection device like a bridge or router. Connection media include twisted wire cables, fiber optics, phone lines, infrared light, and radio signals. Packets of data run through the network connections to reach their destinations.

Network Topologies

Networks are usually connected together in one of three ways. These connection standards are known as topologies. In the bus topology, several computers, known as nodes, are connected to the network with a single cable. All nodes on the network can communicate directly with one another.

Ring topology connects each node to two others in the network. Eventually it will form a large circle. Transmitted data must be sent from one node to the next, around the ring, until it reaches its final destination. Ring networks are ideal for large LAN setups because information can be easily transmitted without each node being interconnected directly.

Both ring and bus topologies are known as peer-to-peer networking. This means that users can communicate directly with each other. Each node contains shared resources that may be accessed by others on the network. The user or LAN administrator controls what data may be accessed and by which node.

Star topology relies on indirect communication. All nodes on the network connect with a central switch, known as the control node. The control node handles communication requests. All information requests must go through the central node before reaching the final destination. If the node is shut down for any reason, the network will not work.

Usually one person in the organization is responsible for maintaining the network, making sure that all users cooperate to share disk space, printers, and other resources. This person is called the "network administrator." Since each type of computer, from a Macintosh to an IBM PC to a UNIX workstation, has its own way of storing and transmitting information, LANs can be difficult to configure. But network developers have come up with a set of common protocols that allow various systems to communicate.

OSI Model

A common protocol which is educational to review is known as the Open Systems Interconnection (OSI) model. It is a seven layer transmission process that makes sure each network node receives the data in a format it can understand. Each layer of the process can only communicate with the layers directly above and below it.

The seventh layer, or application, is the only process with which the computer programs have direct contact. The layer takes the entered file and prepares it to be sent over the network by translating it into bytes, or characters of information.

The sixth layer is known as the presentation. It makes sure that the message is transmitted in a language that the receiving computer can understand. Most personal computers use an ASCII format. ASCII is a common computer language that contains 256 characters used in everyday text. These include letters, numbers, punctuation marks, and symbols. This layer also decides whether the data needs to be compressed or coded for easier transmission.

The fifth, or session, layer begins the communication process. It makes sure that each message on the network remains separate and whole. The session layer also directs the transmission to its proper node. The fourth, or transport layer, works with the session. It backs up copies of the information in case the data gets jumbled in transmission.

The last three layers also work very closely together. The network layer decides which path the information should take. It looks at the data to find which packets are going to the same node. The network section can also change the way the packets are sent through the system depending on the amount of traffic on the network. The data-link control layer confirms the information has been sent and received. If the transmission is garbled, it will request that the data be resent until it is done correctly. Finally, the physical layer formats the data for the transmission media. Once the information is received, the various layers will return it to a human-readable, or computer-readable, form.

Network Problems

There are some dangers involved in using a network. Sometimes when one computer on the network breaks down, it will impact the rest of the network. The other nodes may not work at all or be unable to transmit information back and forth.

Computer viruses are another problem. A virus is a software program designed to inflict damage on any computer with which it comes in contact. It may destroy files or cause the system to crash. Although this can be a problem for a single computer, if a virus gets into a network, it can cause massive damage and disruption. To prevent the spread of viruses, programmers have created software to find and destroy them.

Another problem comes from individuals who want access to another's personal files. This can come from inside a business organization, from a supervisor or co-worker, or outside, by criminals who want access to an organization's or person's files. Law enforcement agencies have been slow to recognize this type of criminal activity. Some, for example, view any type of transgression a crime, while others insist that files be damaged or destroyed before taking action. To make matters worse, employers currently have the legal right to read employee E-mail messages and monitor their contributions to outside networks such as the Internet.

While these problems are unlikely to go away soon, individual users can encrypt, or code, their files before sending them through the network. To decode a document, the receiver must have access to the code responsible for encrypting it in the first place. Usually, the user only needs to know the key, or password, for the document.

Networks are now so commonplace that their abilities are often taken for granted. Networks control banking transactions, airline ticketing and traffic, insurance claims, weather services, and scientific research. As society continues moving through the information age, more networks will develop to fit new needs.

u contributed by JDC Editorial Staff

Communications Satellite Corporation (COMSAT)

COMSAT is the private, for-profit organization that was incorporated in February 1963 when the Communications Satellite Act of 1962 was signed into law. The Act provided for the Communications Satellite Corporation to establish America's satellite communications system and represent the United States in international communication endeavors. COMSAT is headquartered in Bethesda, Maryland.

In 1962 the Kennedy administration was putting into place the components needed to further the United States' space interests. One of the more important aspects was a system that provided constant communication with any manned or unmanned space device. The way to achieve this was to set up communication stations or relay stations all over the world. The design, development and acquisition tools needed were the responsibility of COMSAT. Additionally, the advancement in telephone and data transmission that would come from COMSAT's communication interests were of great importance, too.

From its beginning, COMSAT was saddled with tasks and responsibilities that were in some ways contradictory. The new corporation was private yet had to answer to a variety of government agencies, including the Federal Communications Commission (FCC) and the U.S. State Department. Its goal to further the United States' interests was sometimes the opposite of its other goal to accommodate international interests. The contradictions, at times, were confining.

However, great power came from the 1962 Act as well. COMSAT was largely responsible for its own development, management and operations. It was also able to own and operate satellite terminal stations or earth stations; to provide research and development; to acquire facilities and tools; to sell services to users, including the U.S. government; and most importantly, to design the plans and specifications for the entire communications satellite system.

To further this system, the United States and COMSAT hosted 19 countries in 1964 at a Washington, D.C., conference titled the International Plenipotentiary Conference on Interim Arrangements for a Global Commercial Satellite System. The U.S. was anxious to build a global satellite system quickly. The other countries, not having an immediate need, were willing to move at a slightly slower pace by determining the organizational structure first.

The conference, seemingly going the way the United States wanted, ended with COMSAT being charged with the responsibility of managing the new global commercial satellite system to be called the International Telecommunications Satellite Organization (INTELSAT) and all of its interests. This new plan was spelled out in the Interim Agreements signed by 11 countries at the conference.

All 11 countries were participants in the new multi-national endeavor; but, without a doubt, COMSAT was the ruling entity. COMSAT was in control of INTELSAT's operations and, as such, decided its financial, legal, design, development and procurement components. In effect, this gave COMSAT day-to-day as well as long-range control of the entire system.

In 1965, COMSAT, through INTELSAT, launched its first telecommunications satellite, initially called Early Bird and later called INTELSAT I . Throughout the 1960's and 1970's, INTELSAT successfully launched more satellites with more payload and more sophisticated instruments. This allowed for the United States' space program and international telecommunications to flourish. Understandably, as more potential uses arose and more users signed on with INTELSAT, COMSAT faced more and more criticism for America's dominance. But even at home, specific groups of Americans, such as broadcasters, educators and the existing telecommunications industry, were not happy with COMSAT's power, either.

Fortunately COMSAT did an exceptional organizational job and INTELSAT successfully expanded the global communications network. So, although facing criticism, both entities persevered while plans for the second phase, the Definitive Agreements, continued. The initial agreements, called Interim Agreements, suggested a temporary plan, while the Definitive Agreements suggested a stable, future-forward plan. The Definitive Agreements, completed in 1973, in fact addressed many of the problems and issues brought up in COMSAT's first decade. The Definitive Agreements called for creation of a managing body called the Executive Organ. This group, made up of representatives from member countries, systematically took over the day-to-day management responsibilities of INTELSAT. At the same time, COMSAT's role also systematically changed from INTELSAT's manager to the Management Services Contractor. By 1979, the Executive Organ was wholly in charge of INTELSAT and it went on to have a better, more balanced, internationally-designed role in the telecommunications network.

When the FCC declared "open skies" in 1972, competition from private companies threatened COMSAT's satellite services. Many of the corporations that were now allowed to compete with COMSAT had been former users and investors, and many left the organization due to COMSAT's dominance. COMSAT adapted to the competition by engaging in ancillary businesses and by keeping sight of its foundation as a provider of satellite services.

As deregulation hit full stride in 1984, communications companies, such as COMSAT and American Telephone and Telegraph (AT&T), brought their monopolies to an end. Over the years, deregulation not only opened up opportunities for new players, but it also reduced many end-user costs. COMSAT entered this deregulated age with sound, strategic plans. By 1994 its business units consisted of COMSAT Laboratories for commercial research and development; COMSAT Mobile Communications for ship, aircraft and land mobile uses; COMSAT International Ventures to develop communication systems in emerging areas of the world; COMSAT RSI to design the tools necessary for high-tech communications; and COMSAT World Systems, the division that handles all of the communications services through INTELSAT that initially gave COMSAT its definition.

An entertainment division of COMSAT, which is smaller but more glamorous and less regulated, consists of COMSAT Video Enterprises which owns sports franchises, such as the Denver Nuggets professional basketball team; On Command Video, a hotel-guest demand video service; Beacon Communications for film and television production; and a video teleconferencing unit.

COMSAT started its journey as the only supplier of international communications satellite services by leading an international consortium in directions that supported COMSAT's own purposes. When forced to change, it adapted extremely well, and its 1994 annual report showcased a company with over $800 million in revenues, almost $2 billion in assets and nearly 3,000 employees. Perhaps the best example of COMSAT's adaptability and a product the company is very excited about is the COMSAT Mobile Communications unit's laptop computer, which acts as a satellite terminal for personal use. It is slated for introduction in 1996.

COMSAT's ability to successfully compete in the industry it fostered has been a challenge that it has mastered extremely well.

u contributed by Michele Messenger

Conrad, Frank (1874 – 1941)

American inventor and electrical engineer often regarded as the father of radio broadcasting.

Frank Conrad was born May 4, 1874, in Pittsburgh, Pennsylvania. Although he received little formal education, when he was 16 he was hired as an apprentice at Pittsburgh's Westinghouse Electrical and Manufacturing Company. Conrad worked his way up at Westinghouse and became Assistant Chief Engineer in 1921. He remained with Westinghouse until 1941, the year of his death.

While apprenticing with Westinghouse, Conrad began experimenting with electrical equipment and developed a crude wireless receiving set in 1912. By 1919, he was broadcasting records from the amateur radio station he'd built in his garage. When a local department store noticed the popularity of his broadcasts, it began advertising wireless sets for listeners to receive Conrad's programs. The store's innovative advertising strategy led Conrad and his Westinghouse colleagues to recognize radio's commercial future.

After Westinghouse was granted a federal license, KDKA — the first U.S. radio station — was built in Westinghouse's Pittsburgh plant. The first broadcast on November 2, 1920, announced Warren G. Harding's election as U.S. president. This historic event is considered by many to be the birth of commercial broadcasting, and Conrad its father.

Frank Conrad held more than 200 patents for inventions resulting from his years of research at Westinghouse. His short-wave radio experiments led to radio relay of network broadcasts, as well the development of radio transmitting equipment. His other inventions included the round watt-hour electric gauge to meter electric energy use (which remains a common household fixture), and equipment for starting and lighting automobiles. In spite of his many other contributions, Frank Conrad remains best known as the father of radio broadcasting. He died on December 11, 1941, in Miami.

u contributed by Susan P. Sanders

Conroy, Benjamin J., Jr. (1923–)

American cable television pioneer, industry activist, instructor and writer. Former Chairman of the Cable TV Pioneers' Managing Board and the National Cable TV Center and Museum at Pennsylvania State University in University Park, Pennsylvania.

Benjamin J. Conroy, Jr., was born October 28, 1923, in St. Johnsbury, Vermont. He graduated from the United States Naval Academy in Annapolis, Maryland, in l947. He served in the U. S. Navy from 1943 until 1954, and was a recipient of the Navy's Commendation Medal.

Conroy made his debut in the cable television business in 1955 in Uvalde, Texas. His business was quite successful, and he soon launched a regional expansion. In addition, he became an involved cable television (CATV) activist, speaking on behalf of the fledgling industry.

Conroy, along with other partners, founded General Communications and Entertainment Company, Inc., which owned and operated a number of cable systems.

From 1968 to 1979, he was Senior Vice President of Communications Properties, Inc. A long-time member of the National Cable Television Association (NCTA), Conroy was National Chairman from 1965 to 1966 and served on the Board of Directors from 1961 to the early 1970's. He is also a member of the Cable TV Pioneers, and served as Chairman of a number of the organization's committees. He was one of the founders of the Texas Cable Television Association and was very active from 1960 to the mid 1970's.

In 1966, Conroy was awarded the NCTA Larry Boggs award. In addition, he received the Texas Cable Television Association's John E. Mankin Award. In 1968, his first book, *The Spelvin Papers — A Critical Exegesis,* was published.

In 1982, Conroy retired from the cable television business and started Conroy Management Services. His offices in Manchaca, Texas, boast an award-winning vegetable garden. They also include a player piano for Mr. Conroy's practice time as he is a jazz pianist and participates in a jazz festival held annually in St. Louis. Mr. Conroy and his wife, Toni, have seven grown children.

u contributed by Valerie Switzer

Continental Cablevision, Inc.

Continental Cablevision, Inc., founded in 1963 in Tiffin, Ohio, is the country's largest privately held cable television company. Based in Boston, Massachusetts, and under the leadership of Chairman Amos Bud Hostetter, Jr., it currently serves more than 4.1 million subscribers in 20 states. Its primary areas of operation are sections of New England, California, the Midwest, Virginia and Florida. It is one of the ten largest multiple system cable television operating companies (MSOs) in the United States. Internationally, the company is developing systems in Singapore and Australia.

In 1963, two years after he received an MBA from Harvard Business School, Amos Bud Hostetter, Jr. and fraternity brother H. Irving Grousbeck founded Continental Cablevision, Inc. The original system served the two small Ohio communities of Tiffin and Fostoria, with headquarters in Tiffin. The organization moved its base of operation to Boston in 1968. (In 1980, Grousbeck left the company to accept a professorship at Harvard.)

The company has expanded throughout the United States by building new cable systems and acquiring other cable franchises. In 1986, it acquired McClatchy Cable, and it purchased American Cable Systems two years later. Fiercely proud of his cable organization and striving to maintain it as a privately held entity, Hostetter has gone to great lengths to keep Continental Cablevision under his control, despite several opportunities for the company to go public. It has been a challenge. He leveraged his own personal worth significantly in the mid-1980's to buy back a portion of the company he had previously sold to Dow Jones & Co.

Throughout more than 30 years of successful growth, Continental Cablevision has tried to provide the highest quality of service to its customers. To that end, it regularly hosts ask the manager call-in customer service programs on many of its own cable system stations. And, it has sought to cater to the cable customer in a variety of ways, including adding evening and weekend office hours and implementing same-day cable installation for new customers. For its efforts, Continental Cablevision has been voted the Operator of the Year in 1988, 1989 and 1990 by readers of *CableVision* magazine. It is noteworthy that Continental Cablevision's very first customers in Tiffin, Ohio, who originally subscribed in 1964, are still customers today.

In addition to its reputation for outstanding customer service, Continental Cablevision has also worked to provide quality programming choices for its subscribers. The company helped found the Cable Satellite Public Affairs Network (C-SPAN), which provides live coverage of the proceedings of the U. S. Congress. In addition, it also helped found Viewers Choice, a national pay-per-view service, and E! Entertainment Television. The company also owns a portion of Turner Broadcasting System (TBS). Continental Cablevision has developed regional networks, such as Florida's Sunshine Network, and the New England Cable News Channel, a joint venture with the Hearst Corporation.

An ardent believer in corporations being good public servants, Hostetter is one of the founders of the highly respected educational cable television service, *Cable in the*

Classroom. This commercial-free programming service obtains copyright-cleared programs from the country's leading educational television producers and provides them free of charge to participating schools. *Cable in the Classroom* was launched in 1989, and programming is currently provided free to more than 70,000 public and private schools by 7,200 local cable company members.

Continental Cablevision was one of the first cable companies to install high-capacity fiber optic transmission systems. In addition, the company is a founding member of Cable Television Laboratories, Inc. (CableLabs) and supports the organization's efforts in researching digital compression as well as developing a high definition television system (HDTV) that will, at some point in the future, allow cable companies to transmit a high-quality, high-resolution picture to subscribers.

In a recent exclusive interview in *Broadcasting & Cable* magazine, Hostetter was asked if he was going to support the introduction of HDTV in cable. Hostetter replied, Absolutely. …The picture quality is discernibly superior. I think you'd pay a big price if you didn't introduce it. You know, in the digital age people are going to be accustomed to that level of picture quality. In the new competitive world, if you are a late adaptee of new technology you're going to get passed by.

Continental also recently announced an agreement with General Telephone & Electronics (GTE) to provide MainStreet interactive television services to more than 540,000 of the company's subscribers. This has moved Continental Cablevision into position as the largest provider of interactive television in the United States.

In a recent joint venture with Singapore International Media Pte. Ltd., Singapore Technologies Ventures Pte. Ltd. and Singapore Press Holdings Ltd., Continental Cablevision will build and manage an advanced cable communications system for the island of Singapore. The company will install a fiber optic/coaxial system intended to reach all of Singapore's 720,000 households, businesses and institutions.

Continuing its international expansion, Continental Cablevision also entered into an agreement with Optus Communications, Nine Network Australia, and Seven Network Limited to form Optus Vision. This new vehicle will provide a wide range of advanced broadband communications and interactive entertainment to Australian cable subscribers. The group has targeted key cities in Australia, including Sydney, Melbourne, Brisbane, Adelaide and Perth, for its initial network installation. The services to be offered are local and international television as well as local telephone calls. The new cable network, expected to be in place in 1998, will provide video telephony services via a fiber-coaxial cable system. Continental Cablevision is also an investor in Teleport Communications Group (TCG), one of the leading alternate access telecommunications companies in the country.

It seems that Continental Cablevision will be inter-continental in the very near future. As one of the country's top MSOs with a loyal and appreciative U.S. subscriber base, Continental Cablevision is expanding to new continents with advanced systems and capabilities.

u contributed by Valerie Switzer

Editor's Notes:
US West bought Continental Cablevision for $10.8 billion in February, 1996. $5.5 billion is in cash and stock, while $5.3 billion goes to pay off Continental's debt. The deal gives US West over 16 million cable subscribers in the U.S., enhancing the company's investments in cable systems owned by Time Warner, Inc.

A number of major companies are working together to develop Intercast technology, an interactive data delivery medium conceived by Intel. The Intercast Industry Group's goal is to create a service which combines television technology with the World Wide Web, allowing end-users to jump between television shows and web pages with the click of a button on a remote control. Companies involved in the effort include Intel Corporation, Continental Cablevision Inc. (under the ownership of US West), Tele-Communications, Inc., Time Warner Cable Programming, General Instrument Corporation, TCI's Headend-in-the-Sky, NBC, Turner Broadcasting, Viacom International, WGBH Educational Foundation, QVC, America Online, Asymetrix, En Technology, Netscape Communications Corporation, Gateway 2000, and Packard Bell.

Colligan, John C. “Bud” (1954 –)

American business executive, currently President and Chief Executive Officer of leading multimedia software developer Macromedia.

John C. “Bud” Colligan was born in Los Angeles, California, on August 14, 1954. While in high school, he attended a brief overseas educational program in France — an experience that ignited his ambition to become a foreign diplomat. While in college, he spent his junior year at a French university. In 1976 back in the United States, Colligan graduated from Georgetown University with a bachelor of science degree in international economics.

After college, Colligan took a position in international finance with Bank of America. The job entailed considerable travel to Africa and South America. Later, while attending Stanford University’s Graduate School of Business, Colligan heard Apple Computer’s founder Steven Jobs address a group of students. It was a speech that would change the direction of Colligan’s life.

After receiving his MBA from Stanford in 1983, Colligan set out to get an international marketing position at Apple. Unable to get a job in his field there, he accepted a temporary position. Later, he was hired full-time as a market analyst to conduct research for the group developing Apple’s groundbreaking Macintosh (Mac) computer. After the Macintosh was launched in 1984, Colligan was selected as International Product Marketing Manager for the innovative new computer. In shortly over a year, Colligan and his team translated Mac’s user-friendly programs into 11 different languages. Fresh from this success, in June 1985, Colligan was named Director of Apple’s Higher Education Marketing and Sales Division, where he helped establish the Mac as a leading computer for schools.

By 1989, multimedia was rapidly emerging as an exciting new domain within the world of computing. Colligan left Apple to become CEO of Authorware, Inc., a Minneapolis-based multimedia firm. The 1992 merger of Authorware and Macromind-Paracomp resulted in the formation of Macromedia, with Colligan named as President and CEO.

Macromedia, based in San Francisco, is a leading developer of multimedia and digital arts software used to create interactive multimedia productions. Macromedia is enabling creative, business, and learning professionals to integrate various media elements (2D and 3D graphics, typography, animation, sound and digital video) into interactive presentations, commercial CD-ROM titles, educational curriculum, corporate training materials, informational kiosks, and printed graphics and many other applications. Macromedia, which produces about 25 percent of the marketplace’s authoring programs, supplied software used to create special effects for the movies *Jurassic Park* and *The Fugitive*.

Under Colligan’s leadership, Macromedia is focusing its marketing efforts on key products, including its two leading sellers, *Authorware*, *FreeHand* and *Director*. The company also has joined other multimedia leaders to establish a worldwide network of media centers at universities.

Known as a visionary within the multimedia industry, Colligan has created a culture at Macromedia based on what he describes as the three R's — respect, responsiveness and results. In the January 5, 1995, issue of *Investor's Business Daily*, Colligan said, "We provide an environment that allows people to have the responsibility, the authority and the accountability for what they do. The motivation comes from doing a great job."

In addition to his responsibilities at Macromedia, Bud Colligan serves on the boards of the International Multimedia Association, S3 Corporation and Intermedia.

u contributed by Susan P. Sanders

Editing Systems

More commonly known as text editors or word processing programs, editing systems allow computer users to create, modify, add to and delete any type of information found on a printed page.

Editing systems, which run the gamut from basic word processing software to powerful desktop publishing networks that manage all aspects of text and graphics production, are versatile programs that create and modify materials ranging from simple letters to complex multimedia documents; provide realistic, on-screen images of these documents, and manage their output to printers or magnetic storage devices.

Editing systems enable the creation of documents by entering information through input devices. Keyboards and hand-held mice are most commonly used for entering such information; however, editing systems are now available that recognize text scanned by optical character recognition (OCR) systems, voice commands transmitted through microphones, and handwriting entered on special pads or on computer screens with an electronic stylus.

This information is translated by the editing system into a format the computer can understand. It is then displayed in an on-screen format that can be modified or navigated using an interactive user interface, also known as an editing window. This interface, which contains all the tools necessary for viewing, editing, and moving through documents, automatically manages the portions of a document the user has selected for viewing and editing by using buffers that hold the active text in the main memory of the computer. When the text is edited, only the information in the buffer window is revised. The main document on disk changes only when the information in the buffer is transmitted or saved.

By limiting changes to a buffer window, text editors allow numerous revisions to the same document. Text in a buffer window can also be combined with the information from the original file and saved to a new file, leaving the text in the original file undisturbed. Many of today's editing systems support easy side-by-side comparison between files by allowing users to view more than one buffer window at a time, either from different files or from various parts of the same file. This multi-file capability also supports text manipulation between files by using cut-and-paste commands that highlight text in one file and import it to another.

The on-screen display created by the user interface most often resembles one or more sheets of paper. Information on these sheets is automatically formatted by the text editor based on preset defaults that determine such factors as page size, margins, type size and style. Most editing systems, including such popular programs as Microsoft Word and WordPerfect, employ a variety of on-screen icons or menus that illustrate available editing and text-handling functions. Users highlight text to be modified by pointing and clicking with a mouse. The desired editing function is then selected using commands entered on a keyboard, by clicking on an icon or pulling down an on-screen menu.

Today's editing systems allow users to view documents in almost the exact format and typestyle in which they will be printed, unlike early text editors that could only display documents in 80-column line lengths and in one standard typestyle. This technology advance, known as WYSIWYG ("what you see is what you get") was developed during the 1970's and early 1980's to satisfy consumer demand for editing software that would be easier to use on personal computers. Apple Computer's Macintosh, introduced in 1984, was the first personal computer to employ a WYSIWYG interface throughout its architecture. Today, this important feature is essential to the on-screen assembly of the most complex documents. It is a standard feature in almost all text editors.

In addition to editing, viewing and output capabilities, most text editors also contain special utilities to further assist document preparation, such as predesigned document templates, spell checkers, grammar correctors, word-count analyzers and thesauri. Some even employ elements of artificial intelligence that allow them to automatically correct common spelling errors.

u contributed by Sonia Weiss

Dewey, Melvil (1851 – 1931)

American educator and librarian, primarily known for devising the Dewey Decimal System for classifying and cataloging books.

Dewey was born in Adams Center, New York, in 1851 and was educated at Amherst College. In 1874 he received his bachelor's degree from Amherst and became the college's acting librarian. In 1876, while completing his master's degree at Amherst, Dewey developed his revolutionary book cataloging system. Using numbers from 000 to 999 to identify general fields of knowledge, it used additional decimals to designate more specific subjects. Known as the Dewey Decimal System, it offers a virtually unlimited number of subdivisions and is used in libraries worldwide.

From 1883 to 1888, Dewey headed the library at Columbia University and directed its School for Library Economy — the first library training school. He founded the New York State Library School in 1887 and directed it until 1906. He also directed the New York State Library from 1889 to 1906.

Melvil Dewey founded and edited *Library Journal* and *Library Notes* and co-founded the American Library Association in 1876. Invention of the vertical office file is also credited to him. He died in 1931 at the age of 80, one of America's most important contributors to library science and information storage and retrieval theory.

u contributed by Kay S. Volkema

Converters

Also known as **set-top boxes**. As used in cable television, the device that changes incoming cable signals to frequencies suitable for television sets. In the delivery of digital information services, the term refers to a computer that processes incoming and outgoing digital signals.

As telephones, televisions and computers become universally linked to the digital information superhighway, they will become one device. This convergence will provide people with access to an unprecedented amount of information and allow them unheard of interaction with that information. A device called a converter will be the central component of this digital system.

Conventional Converters

The converter, now an important part of the cable TV industry, will also play a central role in future information delivery. Also called a set-top box because it traditionally sits on top of a television set, the converter accepts signals from cables and interprets them so your television can understand the information it receives. Some televisions, however, come “cable ready,” meaning the cable plugs directly into the television.

There are two types of converters: the descrambler and the addressable converter. The descrambler works with signals that have been encoded (or scrambled) at the main signal processing center called the headend. The descrambler is authorized to descramble the signal for only those who pay for specific channels and services. The addressable converter works somewhat differently. In an addressable system, the headend has already determined who will get certain channels and pay-per-view services so it doesn’t need to scramble signals. Additionally, some addressable converters are interactive. Users can press buttons on the box or the remote control to order services or programs from the cable company.

Today, converter boxes are manufactured by a number of different companies for sale to cable operators. The cable providers then lease the boxes to cable users.

Future Converters

Converters of the future will be more active devices than they are today. They will be much more like computers. That is because the coaxial cable used by the cable television industry has plenty of room to send information. Although coaxial cable is only a quarter-inch in diameter, it is a pretty wide pipeline for information. One future possibility is a video dial tone that will allow anyone with a converter to plug into information lines and receive a variety of information. Some of the services that may potentially be available through a video dial tone include:

- **Video on Demand.** No more trips to the video store. Order the movie you want when you want it — with the same control your VCR has.
- **Video Telephones.** Talk “face-to-face” with people across the world.
- **Interactive Video Games.** Play video games downloaded from a central video game server. Play against partners across the country.
- **Digital Music.** Get CD quality music through your television.

u **On-line Access.** Hook into computer bulletin boards, receive electronic mail, even access your public library's card catalog from your television.
u **Distance Learning.** Interact with teachers and students located across the country or globe without leaving your home.

Converter boxes will be built with special chips that allow them to remember your favorite programs and services, enable you to program them to block specific services from children, and provide electronic navigation through the information superhighway.

Time-Warner has already begun experimenting with some of these two-way services, particularly video on demand, in a test system located in Orlando, Florida, called the Full Service Network. Also, Cox Cable and U S WEST have each planned to start offering limited interactive services in Omaha, Nebraska.

One problem with these more sophisticated set-top boxes is cost. Converters with many special built-in functions can cost upwards of $600, probably too much for the average consumer. Another problem is developing the software that will run these converter boxes. Software is important because it determines what games can be played, what the television screens look like, and basically how easy the TV is to use. The user-friendliness of these information networks is critically important. Since a large portion of Americans are unable to program their VCRs, the general consumer will certainly be turned-off by complicated and unattractive screen menus. To succeed, the converter must be extraordinarily simple to use.

Controlling the Converter
Before any of these fantastic services becomes reality, the different players involved — the cable, computer and telephone industries — must determine what services they will provide. From that point, they need to decide who will manufacture and control the boxes that allow consumers to access those services.

Another issue is the converter's compatibility. If the information network can be truly accessed through a video dial tone, then like telephones today, any converter should be able to plug into the dial tone. Telephones today may look extremely different from the outside and be manufactured by a number of different companies. But they all can do the same thing—access the phone lines. Likewise, any converter must be able to access any cable line. This need means that companies that manufacture converters must work together and agree on a standard converter that uses a common technology. If this challenge is not met, a video dial tone may never be achieved.

u contributed by Christopher LaMorte

Cox Communications

One of the ten largest multiple system cable television operators (MSOs) in the United States. Headquartered in Atlanta, Georgia, Cox Communications is a 75 percent owned part of parent company Cox Enterprises, which was founded nearly 100 years ago in 1898.

The vast Cox Enterprises media empire got its start in Ohio in 1898 when then 18-year-old James Middleton Cox bought the *Dayton Daily News.* Seven years later, in 1905, he purchased his second newspaper, the *Springfield Press-Republican.* Shortly thereafter, he entered the political arena and was elected to serve two consecutive terms in the U.S. Congress from 1909 to 1913. He was then elected to serve three terms as Governor of Ohio, from 1913 to 1915, and again (two terms) from 1917 to 1921.

Cox ran for President of the United States in 1920 on the Democratic ticket. None other than Franklin Delano Roosevelt was his vice presidential running mate. Cox was defeated, however, by Warren G. Harding, another publisher from Ohio. Cox bought the *Miami Daily News* in 1923, and, in the same year, he started Dayton's first radio station, WHIO. He purchased WSB Radio in Atlanta in 1939 and started WSB-FM and WSB-TV in 1948. In 1950, he acquired *The Atlanta Constitution.* Cox's media empire included seven newspapers, three television stations and numerous radio stations when he died in 1957. In the years that followed, the company continued its expansion by acquiring additional broadcast properties in California and North Carolina.

Cox first got into the cable television industry in 1962 after purchasing a small cable system in Lewistown, Pennsylvania. In 1964, the Cox family chose to consolidate its broadcast properties in a company called Cox Broadcasting, which was publicly held at the time. In 1968, the newspapers owned by Cox were organized under the name Cox Enterprises, which was privately held. That same year, all of the company's cable properties became publicly held Cox Cable Communications. One year later, by 1969, it was the second largest cable operator in the country. By 1977, Cox Cable had expanded its holdings to nine states and had a subscriber base of 500,000. At this same time, Cox Cable once again became part of Cox Broadcasting. The name of the broadcasting division was changed to Cox Communications in 1982, and the parent company once again made the division a privately held entity.

It is noteworthy that James Cox Kennedy, grandson of founder James Middleton Cox, was named Chairman of Cox Enterprises, the parent company, in 1988. He is a 1970 graduate of the University of Denver with a BBA. His early career included time spent working with a group of Atlanta newspapers from 1972 to 1979. From 1980 to 1985, he was President of Grand Junction Newspapers in Grand Junction, Colorado, publisher of the *Grand Junction Daily Sentinel.* He was named Vice President of Cox Newspapers and served in that capacity from 1986 to 1987 prior to his current appointment.

The current President and Chief Executive Officer of Cox Communications is James O. Robbins. After working extensively in both the broadcasting and cable industries, Robbins joined Cox Cable New York City in 1983. He was later promoted to Senior Vice

President of Operations, and he was named President and CEO of Cox Communications in January 1995. Robbins has a BA in American Studies from the University of Pennsylvania and was commissioned as an officer in the U.S. Navy, where he served two tours of duty in Vietnam before attending Harvard University and earning an MBA. While earning his graduate degree, he was Managing Editor of WBZ-TV News in Boston from 1969 to 1972.

It was Robbins and other members of the Cox Communications' management team who helped engineer the 1995 buyout of all of the Times Mirror cable properties for $2.3 billion. The arrangement was finalized in February 1995, and the purchase moved Cox Communications into the position of one of the top five MSOs in the country.

In May 1995, Cox Communications and Times Mirror announced another joint venture. Each organization invested $100 million in a cable programming partnership. The initial products of this joint venture were the Outdoor Life channel and Speedvision. In the agreement, Cox indicated it would provide the two channels as part of its basic service to Cox Communications cable subscribers, and Times Mirror would promote both of the channels in its many publications.

As the name indicates, Outdoor Life will concentrate on a variety of programs dealing with outdoor sports and conservation. Its was launched in July 1995. Speedvision's programming, directed to the motoring fan, will include racing activities, documentaries, and instructional information. It premieres in early 1996. In addition, the company is planning to launch a programming service in Australia in 1995. This will be a partnership with the Cable News Network (CNN), the Australian Broadcasting Corporation and American-based Nickelodeon. The company already has programming available in the United Kingdom. These products, marketed as UK Living and UK Gold, provide basic cable programming to subscribers. The company owns 50 percent of SBC CableComms UK.

Cox Communications actively supports Cable Television Laboratories, Inc. (CableLabs), the research and development organization exploring technological advancement for the cable television industry. It was CableLabs that issued a request for proposal (RFP) in mid-1994 for future cable telephony services on behalf of Cox Communications and five other member cable companies.

Cox Enterprises had anticipated being a participant in a highly publicized joint venture with Southwestern Bell (now SBC Communications), which was a $4.9 billion investment, and the organization also was a behind-the-scenes partner in QVC's effort to buy Paramount Communications. However, both of these ventures were never completed.

Cox Enterprises is also involved in the wholesale automobile industry. In 1991, it merged the Manheim Auctions group with the division of Ford Motor Credit specializing in auto auctions. Other company interests include its purchase of Val-Pak Direct Marketing, a coupon service mailed directly to consumers in larger markets.

One of the country's largest cable television operators, Cox Communications and parent, Cox Enterprises, anticipate celebrating the organization's centennial year in 1998 with even more expansion in the growing telecommunications industry.

u contributed by Valerie Switzer

Robbins, James O. (1942 –   )

American telecommunications executive, cable industry activist, and volunteer. Jim Robbins is current President and Chief Executive Officer of Cox Communications, Inc., a 75 percent owned part of parent company Cox Enterprises, Inc., based in Atlanta, Georgia.

Jim Robbins was born July 4, 1942, in Mount Kisco, New York, and was raised in New York State. He received a BA in American Studies from the University of Pennsylvania. Following graduation, he was commissioned as an officer in the U.S. Navy and served two tours of duty in Vietnam. From 1969 to 1972, he worked at WBZ-TV News, a Westinghouse Broadcasting Company television station in Boston, while he earned his MBA from Harvard University.

Robbins was General Manager of Montachusett Cable Television, a wholly owned subsidiary of the Adams-Russell Company, Inc., in Waltham, Massachusetts, from 1972 to 1974. Later in 1974, he was named Assistant Vice President and Regional Manager of Continental Cablevision of Miami Valley in Dayton, Ohio. He served in that capacity until 1979.

That same year, he moved to Viacom Cablevision of Long Island, New York, where he served as Vice President and General Manager until 1983. In September, he joined Cox as Vice President of Cox Cable New York City. He was later named Senior Vice President of Operations for the company.

In 1985, he was appointed President of the cable division of Cox Enterprises, Inc., and in January 1995, he was named Chief Executive Officer (CEO) of Cox Communications, Inc. Cox Communications is a subsidiary of Cox Enterprises which controls all of the company's cable holdings as well as interests in programming, telephony and technology. A publicly owned company, Cox Communications stock is 75 percent owned by parent Cox Enterprises. The remaining 21 percent is held by public shareholders.

In February 1995, the company purchased all of the cable operations owned by Times Mirror for $2.3 billion. The subscriber base of Cox Communications increased from approximately 1.8 million subscribers to more than 3.2 million subscribers when the sale was completed. Cox Communications is now one of the five largest multiple system cable television operators (MSOs) in the United States.

The legacy of Cox Enterprises began in 1898 when founder James Middleton Cox, who was 18 years old at the time, bought the *Dayton Daily News* in Ohio. Following a lengthy career in politics, which included a bid for the office of President in 1920 with running mate Franklin Delano Roosevelt (in which they lost to Warren G. Harding), Cox continued building his namesake media empire. He purchased the *Miami Daily News* in 1923 and, during the same year, founded Dayton's first radio station, WHIO. Until his death in 1957, Cox added several more newspapers, radio stations and television stations to his holdings. Cox Enterprises became one of the first broadcasting entities to get into cable television when it purchased a system in Lewistown, Pennsylvania in 1962.

In 1968, the Cox cable companies became a publicly held organization named Cox Cable Communications, which managed all of the cable operations. The name was changed again to Cox Communications in 1982. Jim Robbins has been on board at Cox since 1983, and was named President in 1985 and CEO in January 1995.

A former Chairman of the National Cable Television Association's (NCTA) Board of Directors, Robbins is very active in the cable television industry. He currently serves on the NCTA's Executive Committee and is a member of numerous other NCTA committees, including Consumer Relations and Telecommunications. He was recently named Chairman of the Executive Committee of the Cable Satellite Public Affairs Network (C-SPAN) and to its Board of Directors. He also is a member of the Executive Committee for Cable in the Classroom and is Chairman of the 1995 Policy Owners' Examining Committee of Northwest Mutual Life Insurance Company.

Robbins is immediate Past President of the Atlanta Chapter of the Juvenile Diabetes Foundation (JDF) and currently serves as Chairman of the Board of Directors of the Juvenile Diabetes Foundation International.

Jim Robbins and his wife, Deborah Clark Robbins, reside in the Atlanta area. They have three children.

u submitted by Valerie Switzer

Craig, Cleo Frank (1893 – 1978)

American businessman who led American Telephone & Telegraph (AT&T) during the post-World War II technology boom.

Cleo Frank Craig was born in Rich Hill, Missouri, the youngest of seven children of John Stuman Craig and Missouri Ann Davis. Craig's parents had selected the name Cleo before his birth, hoping for a daughter. Craig attended public schools in Rich Hill, where he was valedictorian of his high school class in 1909, and he graduated from the University of Missouri with a BS in electrical engineering in 1913. Immediately after graduation, he went to work in St. Louis for the American Telephone and Telegraph Company (AT&T) as a plant equipment inspector.

Craig held a variety of positions at AT&T plants in the Midwest, and in 1922 he was transferred to AT&T's Long Lines Division in New York City, where he was a plant accountant. He spent from 1925 to 1927 in Atlanta as a division plant superintendent in charge of Long Lines facilities in the southeastern states. Craig then returned to New York City as Special Representative in AT&T's General Department.

Craig became General Manager of Long Lines in 1933 and in 1940 was elected Vice-President of Long Lines and named a member of its board of directors. The following year he joined the board of Bell Telephone Laboratories (Bell Labs) and was appointed AT&T's Vice President of Personnel Relations. Craig was in charge of AT&T's labor relations during World War II and the immediate postwar period. He negotiated with the National Federation of Telephone Workers and settled the telephone workers' 1947 strike against AT&T.

Craig was considered a possible successor to AT&T President Walter S. Gifford when Gifford resigned from AT&T to become Ambassador to Great Britain in 1948. The presidency however, went to another AT&T Vice President, LeRoy A. Wilson. Craig took over Wilson's vacated post of Vice President for Finance and Revenue and was elected to the AT&T board of directors in 1949. When Wilson died in June 1951, the board of directors elected Craig as AT&T's President on July 2, 1951.

Craig headed AT&T at a time when it was expanding and upgrading its facilities to satisfy pent-up postwar demand. The number of telephones in the AT&T system increased from 22 million in 1945 to 46 million by 1955. Accordingly, AT&T's annual revenues increased from $1.9 billion in 1945 to $5.3 billion in 1955.

AT&T made numerous technological advances during Craig's presidency. The new direct-dial technology eliminated the need for large numbers of telephone operators and reduced the cost of long-distance services in comparison with the still-expensive local service. Congressional pressure prompted AT&T to develop new accounting procedures, which resulted in long distance rates subsidizing local telephone service. This cross-subsidization encouraged the growth of competing long distance telephone companies during the following decades.

Craig was also involved in the negotiations with the U. S. Department of Justice that ended an antitrust case filed against AT&T in 1949. The 1956 consent decree accepted by Craig allowed AT&T to retain ownership of its Western Electric production facilities, but the company had to refrain from any manufacturing activities not related to telephone operations. The consent decree prevented AT&T from entering the computer business, which experienced a period of rapid growth after the invention of the transistor by AT&T's Bell Labs in 1948. AT&T made its transistor technology available to any company willing to pay a licensing fee, thereby feeding the growth of the lucrative new industry from which it had agreed to exclude itself.

Craig oversaw AT&T's laying of the world's first undersea telephone cable, a joint venture of AT&T, the British Post Office, and the Canadian Overseas Telecommunications Corporation. The more than 200,000 miles of coaxial cables cost $42 million. The line, which ran from Newfoundland to Scotland, could carry 36 simultaneous telephone conversations. This was three times the previous capacity of the existing radio-telephone link. On September 25, 1956, Craig conducted the line's first telephone conversation with British Postmaster General Dr. Charles Hill.

In late 1956, Craig became AT&T's Chairman of the Board, and Frederick Kappel succeeded him as AT&T's President. Craig retired as Chairman the following year, but he remained a member of AT&T's board of directors until 1960. Craig, who enjoyed golf, hunting, and fishing, was a trustee of the Metropolitan Museum of Art, Cooper Union, Grand Central Art Galleries and Presbyterian Hospital in New York City.

Craig was one of a cadre of executives who rose to power under the guidance, and during the long tenure, of AT&T President Walter Gifford. He continued Gifford's policy of presenting AT&T to the public as a unique company carrying out a national mission to provide full service telephone operations under a government-protected monopoly. But the financial accounting and separations procedures initiated in the 1950's led to cross-subsidies which, combined with the development of the new microwave and computer technologies, later provided market opportunity for competing telephone equipment manufacturers and providers of long distance telephone service — and led to the breakup of AT&T in the 1980's.

u contributed by Diana L. Hollenbeck

Cray, Seymour R. (1925-)

American electronics engineer and computer scientist, known as the foremost designer of high-performance supercomputers capable of handling a tremendous number of calculations in a very brief time.

Cray was born in Chippewa Falls, Wisconsin in 1925 and spent his youth tinkering in electronics. During World War II, he served as a radio operator and then as a specialist in breaking Japanese codes. At the age of 25, he received a bachelor's degree in electrical engineering and another in applied mathematics from the University of Minnesota. His first professional project was working as a computer scientist on Remington Rand's famed UNIVAC, the first commercially marketed computer designed for business purposes.

In 1957, Cray joined what would become a major computer manufacturer, Control Data Corporation (CDC). Over the next 15 years, he designed a number of large-scale computers with high processing speeds. His initial offering was the CDC 1604 — the first fully transistorized supercomputer — built in 1958 and delivered two years later. Cray's 6600, introduced in 1964, was the most powerful computer available for the next few years. The company grew rapidly during the 1960's, and Cray didn't particularly like the subsequent changes.

In 1972, he left Control Data and established Cray Research, Inc. in Chippewa Falls to build and market the world's fastest computers. His first supercomputer, the Cray-1, was completed several years later. By far the fastest and most powerful computer available, the Cray-1 was used for large-scale scientific applications and found its place in university and government labs.

Seymour Cray continued designing supercomputers with ever-increasing speeds, including the Cray-1M and the Cray X-MP. In 1981, he left his position as chairman of Cray Research, Inc. and became the company's independent contractor instead, working out of his own lab and staying on as a member of the board. Several years later, he unveiled the Cray-2, a supercomputer capable of a then-astonishing 250 million calculations per second.

Cray Research restructured in 1989, splitting in two. Seymour Cray assumed leadership of the new Cray Computer Corporation located in Colorado Springs, Colorado, with the aim of building a gallium arsenide-based supercomputer. Cray Research continued with current business. In 1993, Cray Computer introduced the much-anticipated Cray-3, priced around $3 million, with a 16-processor unit priced at $30 million.

But with the Cold War over and government budget cut-backs, Cray's expensive computers no longer had a solid market. In March 1995, Cray Computer Corporation filed for Chapter 11 bankruptcy and the company's future was uncertain.

Having used his name in each of his successively groundbreaking designs, however, Seymour Cray and the word *supercomputer* have become synonymous. Today, he is one of the world's most celebrated computer designers.

u contributed by Kay S. Volkema

Creighton, Edward (1820 – 1874)

American businessman who supervised construction of the Pacific Telegraph between Omaha, Nebraska, and Salt Lake City, Utah. With his profits, he founded a large freighting company, became one of the largest cattle ranchers on the Plains and helped develop Omaha.

Edward Creighton was born near Barnesville, Ohio, on August 31, 1820. He was the fifth of nine children of James and Bridget Creighton, Irish immigrants who met and married in America. While his father provided lessons in self-reliance and justice, his mother supplied him a Catholic fervor that remained all his life. As a boy, Creighton had the reputation of being a daredevil and a scrapper. Occasionally, he made his skill pay dividends. He gave boxing lessons to his youngest brother, John, in exchange for private tutoring in school subjects. Creighton never got beyond fifth grade, but he read a great deal and had a quick intelligence. Often at his side during his teens was another Irish Catholic boy named Phil Sheridan, who later rode to fame as a brilliant Civil War general.

Creighton's first job was as a cartboy on the turnpikes being built through Ohio. When he was 18, his father gave him a pair of horses and a wagon. Creighton promptly went into business as a teamster, hauling freight between Cincinnati and points as distant as Wheeling, West Virginia, and Cumberland, Maryland.

When his widowed mother moved the family to Springield, Ohio, Creighton returned home in 1847 to take his turn in the harvest fields. One day a group of telegraph men passed along the road by his mother's farm. Creighton spoke with them, and his imagination was sparked by the possibilities of the "singing wire." The very next day he set out to secure a contract delivering telegraph poles as far south as Evansville, Indiana. For the next eight years, Creighton hauled poles and wires or supervised the construction of telegraph lines to New Orleans and between various cities and towns in Ohio and Illinois. By 1885, he had no fewer than 40 crews working for him.

In 1856, the ambitious young man looked to the Nebraska Territory and traveled to Omaha to investigate it. Except for its wonderful location on the Missouri River, the town offered little excitement. The streets were ankle-deep in mud and the houses were few and ramshackle. But, Creighton decided it was the place for him. He returned to Ohio long enough to wind up his business affairs and marry his fiancee, Mary Lucretia Wareham. He hurried back to Omaha and started a telegraph business, insisting that a telegraph line to California was not only possible but necessary. If civil war broke out, he reasoned, California might be completely cut off from the rest of the country.

Single-handedly, Creighton set out to survey a telegraph route to the West. After a long and arduous trip, he proved that the route was feasible. Congress then granted $400,000 for the project that was to link East and West. Creighton was placed in charge of construction of the transcontinental telegraph line east of Salt Lake City, Utah. James Gamble was responsible for the Overland Telegraph Company's construction west of Salt Lake. Each put parties to work at both the eastern and western ends of their lines. Creighton took personal charge of the forces working the 1,100 miles westward from

Omaha, Nebraska, to Salt Lake City.

On July 2, 1861, Creighton's force began construction at Julesburg, Colorado. Passing Mud Springs, Court House Rock, and Chimney Rock, the workers reached Scott's Bluff, Nebraska, 27 days later and Fort Laramie, Wyoming, on August 5. A station was set up every night to telegraph orders to Omaha for materials and receive the latest news. It was hot, exhausting work, requiring long hours under primitive conditions, but the line was built at relatively top speed.

Members of the expedition were ordered to treat the Indians well. Gifts were given to the Indians, and anyone getting into trouble with them was immediately dismissed from the service. When the line reached Fort Bridger, Utah, Creighton conspired to get Chief Wash-e-ka of the Snake tribe to visit that office, and a leading Sioux chief to visit Horseshoe Station, west of Fort Laramie. These chiefs, leaders of two of the most warlike tribes on the Great Plains, were friends. With telegraphed questions and answers, Creighton convinced Chief Wash-e-ka that his friend was at the other end of the line. Each chief was told the telegraph was the voice of the Great Spirit Manitou and must never be harmed. Still skeptical, Chief Wash-e-ka asked the other chief to meet him at a point halfway between the two stations. They met and were convinced. For years their tribes rarely disturbed telegraph lines. Later on, upon realizing that the "talking wires" were used to send military information, the Indians tried to destroy them. During the Civil War (1861 to 1865), the government could provide little protection for the lines. Even after the Civil War, Creighton had only 30 men to guard 300 miles of line through hostile Indian territory.

Creighton's men completed the line to Salt Lake City on October 17, 1861, constructing their final joint at Fort Bridger, Utah, about 100 miles east of Salt Lake City. That night Creighton sent the first Utah telegram from Fort Bridger to his wife in Omaha. The next day Mormon leader Brigham Young sent the first official telegram. This event was important because rumors had circulated that Utah and California had seceded. With no ties of rapid communication to connect the West with Washington, D.C., it was feared that the western states, with many thousands of southerners, could not be held in the Union.

The two lines were joined, and the Atlantic and Pacific linked in communication on October 24, 1861. The first transcontinental message was from Chief Justice Stephen J. Field of California to President Abraham Lincoln. Amazingly, the line became a reality in only three months and twenty days. Almost overnight a watch became the measure of time.

The line grew rapidly and profits piled up. In fact, the entire line probably cost less than $400,000, but it made a fortune for Creighton. He had bought $100,000 worth of Pacific Telegraph's stock for only 18 cents on the dollar. After the transcontinental telegraph line's mission was accomplished, the Pacific Telegraph was merged with Western Union, on March 17, 1864. Pacific Telegraph's $1,000,000 of capital stock was exchanged for $3,000,000 of Western Union which issued a 100-percent stock dividend.

When Creighton left Western Union in 1867, he disregarded the construction of the Union Pacific and Central Pacific railroads and founded a large freighting business, hauling wagon caravans of goods to the West. Noticing that cattle left to roam by the builders of the lines were fat and sleek, he then became one of the largest cattle ranchers on the Plains and helped to develop Omaha, Nebraska, where he had large real estate and banking interests. Four years after his death, part of his fortune was used by his widow to establish Creighton University in Omaha (chartered 1879).

u contributed by Diana L. Hollenbeck

Customer Premises Equipment

Terminal equipment that is located at the customers' premises (home or business) and is connected to the telephone network. The connection can be through wiring or by radio frequency. The most common customer premises equipment (CPE) is the simple telephone set found in a residence. But CPE can also refer to the complex private branch exchange (PBX) used by a large business to interconnect all of its employees.

History

When the Bell Telephone Company began operation in 1877, one of its founders, Gardiner Hubbard, believed that all telephone equipment should be rented to, not owned by, the subscribers. This would allow the company to control the quality and type of equipment hooked into its network of lines as well as to allow the interconnection of all equipment. This was a controversial idea at the time but one that endured at American Telephone & Telegraph (AT&T) for nearly one hundred years. During AT&T's monopoly of the telephone industry, its subsidiary, Western Electric, manufactured all of the telephone equipment used by AT&T's customers.

Following World War II, telephone technology was advancing at incredible rates, and other companies wanted to get into the telephone equipment business. AT&T held that it had a right to deny service to any of its customers found using non-Bell telephone equipment, and, according to existing regulations, it did. The first major challenge to this position occurred in 1955 when the makers of Hush-A-Phone, a small plastic cup that fit over the telephone's mouthpiece, took AT&T to court. The Federal Communications Commission (FCC) decided that since the Hush-A-Phone was a purely acoustic device that did not connect electrically to the network, AT&T couldn't prevent its use on Bell telephones. The decision was appealed, but the initial ruling opened the door for other manufacturers to challenge AT&T's hold on CPE.

During the late 1950's and early 1960's, many customers began to feel that they had the right to own their own telephones and should be able to decide from whom to buy them. There were indeed several manufacturers already providing illegal telephone equipment. Whenever Bell System employees found such equipment, however, they would disconnect it and threaten to disconnect the subscriber from telephone service. The controversy came to a head when Carter Electronics Corporation took AT&T to court for not allowing customers to use the Carterfone, a device that allowed two-way radio users to connect to the telephone network. In 1968, the FCC decided that the Carterfone could be connected to Bell lines and struck down the existing interstate tariffs prohibiting the attachment of customer-owned equipment to the public telephone system.

This decision was quickly followed by others that permitted even freer attachment of customer-owned equipment. By the end of 1970, it was estimated that almost 1 percent of Bell customers were using a competitor's equipment. AT&T continued to fight this interconnection, but in 1974 a massive antitrust suit was brought against AT&T by the Department of Justice. One of the major complaints in the lawsuit concerned AT&T's alleged attempts to obstruct interconnection of competing terminal equipment. AT&T fought the validity of the lawsuit for several years before it actually went to court, meanwhile losing ground in its fight to stop interconnection.

In 1982, the lawsuit was settled and culminated in the 1984 breakup of the Bell System. One result was that the CPE market became fully competitive. Customers were free to own their own telephone equipment and buy it from whomever they wished. In addition, the Bell operating companies were also free to buy their CPE equipment from different suppliers. By the end of 1990, there were over 10,000 suppliers of telephone equipment, both large and small.

CPE Today

Today, CPE consists of everything from simple residential telephones to complex PBXs and a myriad of peripherals . Telephone/radio combinations, fax machines, and computers are all hooked into the wired telephone network. In addition, wireless technology allows millions of cellular phones to interconnect with the wired network from almost anywhere. Although the regional Bell operating companies (RBOCs) and AT&T still provide much of this equipment, there are several other major players in the marketplace.

Any piece of equipment that connects to the public switched telephone network (PSTN), whether by wire or radio frequency, is considered CPE. There are industry standards that each manufacturer must follow to allow for interconnection, but beyond that, the equipment can do almost anything the public is willing to pay for. In many residences, there are standard telephone sets as well as answering machines , combination radios and telephones, and computers with telephone line connections. Small businesses have key telephones that are able to answer more than one line plus provide any number of services, such as intercoms, hands-free answering, and conferencing. In addition small businesses may have fax machines and computers for transmitting data over telephone lines. Larger businesses may have a network of simple or complex telephone sets tied to a PBX or Centrex system. Some may have automatic answering and identification devices attached to them. Call routing may be handled by another piece of equipment.

And this is really only the beginning of what is proposed. Some futurists see everyone using a combination telephone, television and computer as a master communications device in the not-too-distant future. And from this comes another controversy. The phrase *customer premises equipment* would, by strict definition, imply *any* equipment residing at the customer's premises. However, CPE is a term that has historically and legally referred to *telephone* equipment. As the world of telecommunications evolves into the world of information networking, including items such as computers and televisions, some industry insiders feel that the historic definition becomes inadequate. A new industry is emerging of which telecommunications is only a part, and it is probably no longer correct to refer to every piece of hardware connected to this network as CPE. In the future, CPE may still be the terminology of choice, it may be replaced by another generic term such as "terminal equipment," or it may be replaced by several more specific terms.

u contributed by Linda Stranahan

Daniels, Bill (1920 –)

American cable television pioneer, entrepreneur, cable TV systems owner and operator, broker and financier, banker and humanitarian. Bill Daniels's vision and business acumen have helped forge the burgeoning cable television industry.

Born in Greeley, Colorado, on July 1, 1920, Daniels grew up in Hobbs, New Mexico, a small town best known for its oil fields and proximity to West Texas. At his parents' urging, Daniels attended the New Mexico Military Institute (NMMI) in Roswell. He attended NMMI for 4 years, beginning in his junior year in high school. Twice during his studies at NMMI, he was the New Mexico Golden Gloves champion.

At the beginning of World War II, Daniels enlisted in the U.S. Navy and served as a fighter pilot. He is credited with shooting down 11 enemy aircraft and received the Bronze Star for bravery. He was a Full Commander of the U.S. Navy when he retired. In 1952, following his discharge, he returned to Hobbs, where he planned to take over the family oil-field business. However, his brother, Jack, who had been in charge during his absence, convinced Bill that he should sell Jack his share of the family operation for $5,000.

On his way to Casper, Wyoming, to start his own oil-field insurance business, Daniels made a stop at a local pub in Denver for a corned beef sandwich. It was at Murphy's Bar that he first saw a television set, which was broadcasting the Wednesday night fights live from New York. At that moment, Daniels concluded that television was a most remarkable invention. So much so, that Daniels created a cable television (CATV) company in Casper shortly after he arrived.

In the summer of 1953, cable television made its debut in Casper. It was the first cable television system in the country to relay broadcast signals via microwave technology. It wasn't long after that Daniels foresaw the impact that cable television would have on the United States. He knew then that one day the entire nation would be linked by cable and that, at some point, cable subscribers would have two-way capability. Daniels's joint venture with General Telephone and Electronics (GTE) in Carlsbad, California, is doing just that. A state-of-the-art, fiber-optic test project, "Main Street" currently offers cable subscribers two-way capability.

Daniels's cable television company, Daniels CableVision, a subsidiary of Daniels & Associates, has owned and operated cable television systems in nearly every state in the country. In an effort to concentrate on the brokerage division of his business and have greater involvement in regional sports ventures, Daniels merged his cable systems division with United Artists Communications in August 1988. (Tele-Communications, Inc. (TCI), the country's largest multiple system cable operator, later purchased United Artists Communications, which subsequently became known as United Artists Entertainment.) At the time of the merger, Daniels's cable systems operating division was one of the top 25 multiple system cable television operators (MSOs) in the country. In addition to the Carlsbad cable system, Daniels still owns Desert Hot Springs Cablevision. These two systems serve more than 90,000 cable subscribers in 12 communities.

Since creating his first cable system in 1953, Daniels has started and sold, or has brokered the sale of, many of the largest cable systems in the country. Seven of the 10 largest cable companies in the country are owned by former Daniels employees or partners.

Ted Turner, American broadcaster and cable pioneer himself, credits Daniels with helping launch Turner's Cable News Network (CNN). In addition, Daniels helped Turner fend off a hostile takeover of Turner Broadcasting in 1987.

In 1985, Daniels started Prime Ticket Network in southern California with Los Angeles Lakers' owner Jerry Buss. In 1994, he sold Prime Ticket Network to TCI.

For many years, Daniels's cable television brokerage and investment banking company, Daniels & Associates, led the industry in total sales. In 1989, the organization set an industry record by completing more than 55 transactions with a total value of $5.4 billion. Daniels's firm is credited with closing more than 46 percent of the cable sales made by major brokerage firms between 1986 and 1991. The company remains one of the industry leaders. More recently, Daniels has expanded the business to include specialized services for the mobile communications industry, including cellular.

In September 1988, Daniels moved his organization to new headquarters in the Cherry Creek area of East Denver, where both his business and personal residence have been located since 1958.

In March 1989, Daniels, along with Dr. John C. Malone, president of TCI , and Dr. John McMullen, television entrepreneur, formed a partnership to launch Prime Network. This network produces and markets regional sports programming in selected regions of the country. In some areas, it is known as Prime Sports Network (PSN).

Although he did not complete his studies to receive a college degree, Daniels is an earnest believer in the value of higher education. In November 1988, he gave the single largest financial gift ever to the University of Denver (DU). The gift of $11 million was earmarked as a matching grant for the Graduate School of Business. Daniels's request was that DU expand its MBA program to include required courses on ethics, integrity, negotiation, courtesy and a host of other socially valued qualities, all intended to help enlighten tomorrow's business leaders. In his honor, the University of Denver renamed the business school the Daniels College of Business. In spring 1995, Daniels gave a second gift of $10 million to the University of Denver's Daniels College of Business.

Never one to forget his humble beginnings, Daniels founded the Young Americans Bank in Denver in 1987. The bank was designed to accommodate the region's youth with a smaller-scale customer service counter and other junior-sized appointments. Today, it has more than 18,000 customers under 22 years of age from all 50 states and 10 foreign countries.

Throughout his career, Daniels has received countless awards for his service as an outstanding humanitarian and cable television pioneer. In 1956, he was elected the second Chairman of the National Cable Television Association (NCTA). He was the first recipient of the NCTA's Larry Boggs Award (now known as the Vanguard Award). In September 1986, he received the Walter Kaitz Award presented by the Walter Kaitz

Foundation. In 1989, the Denver Advertising Federation presented Daniels with its “Fame and Fortune Award” for his commitment to the highest standards of advertising. In 1991, he was inducted into the Broadcasting Hall of Fame, and he was honored with a special Emmy Award from the National Academy of Television Arts and Sciences (NATAS) in 1992 for his remarkable record of achievement in the development of television. In addition, he is listed in *Forbes* magazine’s Top 400 Wealthiest Americans.

A sports enthusiast, Daniels is part owner of the Los Angeles Lakers basketball team. He is an early riser who gets up daily at 4:00 A.M. to read an extensive list of newspapers before arriving at his office.

Bill Daniels, one of the country’s most well-known cable television pioneers, continues to be a major force in the ever-changing cable television industry.

u contributed by Valerie Switzer

Davidson, Jan (1944 –   )

American educator and entrepreneur who founded educational software publisher and distributor Davidson & Associates, Inc.; currently President of Davidson & Associates, Inc.

Born on February 23, 1944, Janice Koertge grew up in a small Indiana town. In 1962, she left for Purdue University to study literature. During her second week there, she met Bob Davidson at a fraternity mixer. After receiving her degree, the new graduate married Bob and moved to the Washington, D.C. area. Jan Davidson attended the University of Maryland, where she earned a master's degree in communications and a Ph.D. in American Studies.

The Davidsons moved to Southern California in 1970 and she took a teaching position. In the late 1970's, Dr. Davidson was one of the co-founders of Upward Bound, a community-based, non-profit tutorial service in Rancho Palos Verdes, California. While continuing to teach, as well as tutor students at Upward Bound, Davidson began to envision the potential use of computers as learning tools. With a friend, she developed a software program to teach speed reading. In 1982, with $6,000 borrowed from her three young children's college funds, she launched Davidson & Associates, Inc.. Its first product, *Speed Reader* — packaged in a three-ring binder — was an immediate success.

Soon Davidson & Associates, Inc. introduced other educational software products, including *Math Blaster* and *Word Attack*. They merged vocabulary and math drills with video game-type sound and action — a combination now often referred to as "edutainment." Davidson's successful early marketing efforts were focused on Southern California schools, where her background as an educator was crucial to her credibility.

By 1986, Davidson & Associates, Inc. had sales of $4 million annually. Dr. Davidson tried to recruit her husband, Bob — a lawyer and business school graduate — to join the firm and manage the business side while she concentrated on product development. It was 1989, however, before she could persuade him to become Davidson & Associates, Inc.' CEO.

Today, Jan Davidson is credited with providing the vision that drives Davidson & Associates, Inc.. Under her guidance, the company has become a leader in developing, publishing and distributing award-winning multimedia educational software. In the consumer education market, the company has formed collaborative relationships with Fisher-Price and Simon & Schuster. In addition, Davidson & Associates, Inc. is active in the school market and brings over 1,000 educational programs to schools nationwide through its Educational Resouces Division, a major reseller of packaged software.

Davidson & Associates, Inc., located in Torrance, California, now employs over 650 people, and its 1994 revenues approached $90 million. Dr. Jan Davidson speaks nationwide on the growing collaborative relationship between education and technology. In an address she delivered in March 1995, she remarked, "What does technology offer that the textbook cannot? For one, active learning. The students are engaged, they are active participants, seeking their own information, constructing their own understanding. You can see the excitement on their faces. For many, it is the first time they understand history in the context of their own lives."

Jan Davidson has been honored by the American Academy of Achievement with its Golden Plate Award and was the recipient of the Arthur Young and *Venture Magazine* Entrepreneur of the Year Award. She helped found the Computer Learning Foundation and is active in the Software Publishers Association. Dr. Davidson has served as an advisor for the Graduate School of Management of the University of California in Los Angeles. In 1994, she was elected to the Pepperdine University Board of Regents.

Somehow amidst her other activities, Dr. Davidson still finds the time to haunt toy stores seeking inspiration for new products to encourage students to learn. In a February 28, 1994, *Business Week* article, she explained her notion of lifelong learning. "If one of these programs makes kids more confident in their ability to learn, that will help them do well in school. The result is that they'll love learning, they'll learn the rest of their lives, and they'll take responsibility for their own learning." Dr. Jan Davidson — pioneer and influential spokesperson in the field of educational software — remains a teacher at heart.

u contributed by Susan P. Sanders

Direct Broadcast Satellite (DBS)

The generic term for a wireless television distribution technology that transmits a signal from a ground-based satellite earth station, called an uplink, to a satellite, then directly to satellite dishes located at customers' homes. DBS can use low-, medium- or high-power satellites for signal distribution.

In 1980, the Federal Communications Commission (FCC) began the process of licensing companies for permits to provide DBS satellite service. DBS companies fell into three categories based on the type of power they used to deliver their signals: C-band low power (2 to 15 watts), Ku-band medium power (20 to 60 watts) and Ku-band high power (100 to 200 watts). Of the three types of service, C-band has been especially popular in rural areas where broadcast signals are difficult to receive and cable systems too expensive to build, resulting in almost four million dishes being installed. Because of the low power (2 to 15 watts) of the satellites, C-band reception requires an antenna eight to ten feet in diameter, called a television receive only (TVRO) dish. Although it is possible for owners of C-band dishes to receive unauthorized signals by using illegal decoders, scrambling techniques developed in 1990 by General Instruments make it extremely difficult and expensive to receive unauthorized signals.

Medium-power satellites (20 to 60 watts) require a dish three to four feet in diameter; however, the signal is susceptible to interference from rain. High-power satellites (100 to 200 watts) use a dish one to three feet in diameter. High-power DBS is capable of digital satellite service (DSS) and digital compression, which will increase the channel capacity 3 to 15 times over what is possible with an analog signal. High-power DBS can deliver a laser-disc quality television picture and digital sound with quality equal to that of compact-discs. In addition, DSS capability will enable DBS to transmit signals to high-definition television (HDTV) sets when they become available to consumers.

For high-power DBS, the receive dish, a small parabolic antenna, is called an integrated receiver/decoder (IRD) and is equipped with a low-noise amplifier. The signal is converted from super high frequency (SHF) to lower frequencies that can be used by the customer's television set.

DBS offers many of the same programs that are available from cable television; however, with its expanded channel capacity, it promises to have 40 to 50 movie channels, offering near video-on-demand (NVOD) now and possibly true video-on-demand (VOD) in the future. Since the DBS signal does not originate in the area that is served and is transmitted directly to the consumer, DBS providers are prohibited from transmitting local broadcast signals.

In addition, one of the primary stumbling blocks to the expansion of DBS service has been the inability of providers to develop programming not already being delivered by broadcast or cable television. Although provisions in the Cable Act of 1992 made all cable programming available to DBS providers, the DBS industry has yet to develop any of its own distinctive programming.

Originally, DBS was thought to be most valuable for areas not served by cable. The early acceptance of C-band service was primarily in rural areas not served by cable where a large dish was not restricted by laws or covenants. With the increase in satellite power and the associated technology that allows reception with smaller antennas or satellite dishes, DBS has also gained popularity in urban and suburban areas, thus becoming a competitor of the CATV industry.

In 1994, three DBS companies began providing service, including DirecTv, a subsidiary of Hughes Communications; PrimeStar, owned by a conglomerate of cable television companies; and United States Satellite Broadcasting (USSB), a subsidiary of Hubbard Broadcasting. Since the geographical area covered by a DBS satellite signal, called a footprint, includes the entire continental U.S., DBS is available to every television home from the time the satellite is operational.

The next step in developing DBS-based products and services will come with advances in digital technology. This will potentially allow DBS providers to also deliver video telephony, distribute video to theaters, provide computer access to libraries, offer video publishing of magazines, and distribute audio by digital radio or directly to stores.

Many experts predict that the future viability of the DBS industry depends on which area is being discussed. Low-power DBS will probably lose popularity when new scrambling techniques make it much more difficult and expensive to pirate signals and when medium- and high-power DBS begin offering a wider channel selection. The future of medium-power DBS is also in question because of the push by high-power DBS providers to expand their programming and service capability.

u contributed by Paul Stranahan

de Forest, Lee (1873 – 1961)

American inventor, often regarded as the father of radio in the U.S. and self-proclaimed first disc jockey, but primarily known for his invention of the amplifier vacuum tube (triode), which revolutionized electronics.

De Forest was born in Council Bluffs, Iowa, in 1873. Displaying an early interest in science, he invented several mechanical gadgets by age 13. He attended the Sheffield Scientific School at Yale University on a scholarship, receiving his doctor of philosophy degree in 1899.

Although de Forest earned his living in various traditional ways, he was continually experimenting in electronics. In 1907, he added a third element to Sir Ambrose Fleming's vacuum tube — a grid separating the cathode and the anode — that greatly enhanced the tube's ability to detect transmissions of wireless stations. This triode, which de Forest called the Audion tube, was his greatest single invention: it was able to transmit sound, music and speech through space for the first time. The tube's practical uses included telephone long lines and radiotelegraphy at sea. To take advantage of the Audion's increasing business applications, de Forest founded the Radio Telegraph Company of New York in 1907. But the venture did not succeed.

De Forest also began broadcasting radio programs with the Audion's help. In 1910, he presented Enrico Caruso live from the Metropolitan Opera — the first live opera broadcast. In 1916, he aired the first news program which covered the presidential election results. He also established the first radio station that year, airing news bulletins and phonograph records at regular intervals.

The next year, AT&T bought the rights to the Audion tube and other expertise from de Forest for $300,000. This enabled AT&T to enter the fledgling radio broadcasting business, where it quickly became a major player.

In the 1920's, de Forest developed Phonofilm, which put sound on motion picture film, and he presented the first public talking movie at New York City's Rivoli Theater in 1923. But de Forest failed to market Phonofilm effectively, and Movietone (a similar process backed by the Fox Film Corporation) became the industry standard instead.

Lee de Forest died in Hollywood, California in 1961. With over 300 patented inventions, he is considered an electronics pioneer who greatly advanced telecommunications.

u contributed by Kay S. Volkema

Dell, Michael Saul (1965 –)

American entrepreneur, founder, Chairman of the Board and Chief Executive Officer of Dell Computer Corporation. Michael Dell is best known for his aggressive leadership of Dell Computer Corporation and the company's meteoric rise to the position of fifth largest computer company in the country.

One of the computer industry's youngest legends today, Michael Dell was born February 23, 1965, in Houston, Texas. Also legendary is the mail-order stamp business he started at age 12 and ran from his parents' home. Within a very short period of time, his stamp business was realizing gross monthly profits of $2,000. At age 17, he purchased his first BMW.

In 1983, at age 19, he entered the University of Texas at Austin as a "pre-med" student. From his dorm room, Dell sold computer components and RAM (random-access memory) chips for IBM personal computers. At the time, IBM dealers were committed to buying large monthly quantities of computers from IBM, and many sold their remaining overstocked inventory to Dell. Originally known as PC's Limited, the company soon expanded. Dell began customizing each computer ordered and resold it directly to the buyer at greatly discounted prices. Dell originally marketed his products via advertising placed in local newspapers and then included ads in national computer publications in the advertising campaign.

By April 1984, Dell was making approximately $80,000 per month in gross sales. Convinced that he could take the business to greater heights, he decided to drop out of college. Soon after, he began making his own line of computers, which were very much like IBM's. Continuing the sales strategy he started in college, he sold the computers directly to the end user at sizable cost savings, sometimes for as little as 40% of the cost to purchase an IBM.

In 1987, he renamed the company Dell Computer and began an expansion program that included adding its first international subsidiary in Great Britain. Continued growth followed. In 1988, he expanded the company again by adding government agencies to the market mix. Dell also created a sales staff specifically trained to service larger accounts. In the same year, Dell Computer initiated a public offering, raising nearly $32 million.

During the company's steady rise, Michael Dell was involved in almost every aspect of the organization. In 1989, after having realized steady and astonishing growth, the company hit a setback. Earlier that year, the company had launched an effort to develop a new personal computer and found that, due to very high costs of proprietary components, its efforts were eating up revenues. It was forced to report a 64% drop in profits. In 1990, the company entered the retail market through an agreement with CompUSA.

Following the initial public offering in 1987, the company experienced record growth by introducing several new products. At the close of fiscal year 1990, the company saw a dramatic drop in net income due to oversupply of some products and Dell's decision to drop the design and production of an engineering workstation.

Michael Dell has been known, through the early 1990's, for his forthrightness and brash candor in responding to any kind of criticism about the company. When the organization announced a planned second public offering in November 1992 to raise more than $150 million, some market analysts were critical of the company's reporting practices for currency hedging in foreign markets. In true style, Michael Dell launched an aggressive defense of his actions and instead attacked the judgment of his critics.

Today, however, it seems that the obstacles and financial setbacks as well as the dazzling accomplishments of Dell Computer have helped shape Michael Dell into a world-class corporate leader. Tempering his business savvy with wisdom and maturity, Dell has also hired a variety of top-level management specialists who have helped him guide the company in a number of areas, including marketing and foreign expansion.

The rapid rise of Michael Dell and Dell Computer Corporation, from humble beginnings in 1984 to its current position as the fifth largest computer company in the United States, will remain legendary for years to come.

u contributed by Valerie Switzer

Digital Compression (also known as data compression)

A method of representing data in an abbreviated form by removing redundant data, by replacing repeated data with a shortened code, or by using mathematical formulas.

A computer understands information when it is represented it in a series of ones and zeros called binary digits (bits). When a computer converts information into bits, it is called digitization. One advantage of storing data digitally is that the computer can easily manipulate it. And one of the most useful ways data can be manipulated is by compressing it. Compressed data is like shorthand for a computer because the same information can be represented in a shorter form without significantly changing its quality or meaning. Almost any type of digital data, whether words, pictures, music, movies or computer programs, can be compressed. Compression allows data to be sent faster (because there is less to send) and stored more easily (because there is less of it).

Types of Compression
There are several ways that data can be compressed. One type of compression converts all redundant data (data that appears more than once) to a shorter code. This type of compression is called lossless because the compressed data is completely restored when it reaches its destination. For example, if a word-processed document uses the word *encyclopedia* many times, a compression program looks for that word and replaces it with a code word that takes up less space. A decoder program is then used to expand — or decompress — the information and display it in its original form. Lossless compression is used for types of data, such as computer software or text files, that would suffer tremendously if any portion of the original file was missing at the receiving end.

Another form of compression eliminates redundant data to save space. This type of compression is called lossy. This means that when data is decompressed at the receiving end, portions are missing. Though the quality of the decompressed data will not be as high as the original, the data remains usable. The human eye or ear compensates for what's missing. Video and audio information are types of data that can be compressed using lossy techniques.

For example, if a video is digitally compressed, the computer eliminates elements of the video that are used repeatedly. So if the background stays the same for the duration of a video, the computer only stores the background information once and reproduces it for every frame. This is similar to how artists draw cartoons. Illustrators keep one background and simply move the figures around it. This eliminates the need to draw the same background for every frame. Using lossy data compression, a standard-sized audio compact disc (CD) can be saved on a 2-inch mini-disc. That is because redundant data has been stored only once and reused as needed. Though there is some data loss, the human ear is not able to detect the difference.

Unfortunately, the more video or audio signals are compressed, the worse the signal quality becomes. Digital video that appears jerky or audio that sounds flat has probably been greatly compressed, usually because of storage concerns or the limitations of a computer's memory ability. The transmission medium — airwaves, fiber optic cable, coaxial cable, copper wire — also determines how much the signal will need to be compressed because each have different bandwidth capacities. (Bandwidth refers to how much information a transmission medium can carry at one time.) Fiber optic cable, for example, can handle more data at one time than any form of copper wire can, so information does not need to be compressed as much (or even at all) if sent through fiber optic cable.

Fractal compression is a newer way to compress digital signals. This compression method is based on the discovery that one small segment of an image — such as a photograph of a mountain — is geometrically similar to the whole object. A single fern leaf, for example, consists of a geometric pattern similar to the entire fern of which it is a part. Using fractal analysis, it is possible to study one small segment of an object and produce a mathematical formula to represent the shape of the whole. Though fractal compression technology is relatively new, it promises to compress data to a larger degree than currently is possible with conventional compression methods. The decompressed image also retains a higher quality than with older lossy compression techniques because less information is discarded.

Uses and Benefits

In addition to saving storage space, compressing data also reduces data travel time. When data travels through telephone lines, such as when digital information is sent from one computer to another, it may take a relatively long time. That is because today's fastest modems can only handle 28,800 bits of data every second. So sending or receiving a piece of information that consists of several million bits can take a comparatively long time. A three-minute segment of high-quality music that has been compressed to one-third its original size still may still take up to an hour to send because it is made up of many million bits of information.

Reducing the time it takes to send information saves money associated with data transmission. For example, telephone charges are reduced because modem connections between computers exchanging information are shorter. Similarly, compressed files reduce usage charges from commercial on-line services that charge hourly rates because compressed files can be downloaded and uploaded faster than uncompressed files. Businesses that use satellites to send information to various locations can save satellite usage charges by compressing information before they send it.

In the near future, television and cable broadcasts will switch from analog signals to digital signals. When this happens, digital compression will be a crucial technology. That is because when analog television signals are converted to digital, the amount of "space" (bandwidth) they occupy in any particular transmission medium expands. A digital television signal can take up to 45 times more space than an analog version of the same signal.

If that digital signal is compressed, however, then it is possible to put a digital broadcast signal in the same amount of space as an analog version of the same signal. In fact, if the digital signals are compressed enough, many of them can fit into the same amount of space that a single analog signal occupies. Therefore, digital compression will allow the number of television channels currently available to greatly expand.

In the future, as full motion digital video is compressed and sent to cable customers, a set-top box (also called a converter box) will decompress the video so that it can be displayed on the screen. Converters designed to decompress digital signals will actually be powerful microcomputers that can translate the incoming digital signals into video. Converter boxes are used with cable television systems today, but their function is quite different. Instead of decompressing signals, today's converter boxes decode analog signals that have been scrambled and also allow the television set to understand frequencies that it was not manufactured to receive.

Compression Standards
Because compressing data is basically coding data in a specific way, a standard understanding of that code must be used. Modems that share information must have a standard program to compress and decompress information. Other standards have been developed for visual images. One such standard code is called the Motion Pictures Expert Group standard, or MPEG. The Joint Photographic Experts Group (JPEG) publishes a compression standard used for still photographs. Finding a suitable compression standard that various information providers can agree upon is an important step in implementing new information services.

u contributed by Christopher LaMorte

Diller, Barry (1943 –)

American media businessman, known for developing the Movie of the Week and mini-series television programming formats, and who is best known as a pioneer of interactive TV. Diller is the former Chairman of QVC Network, Inc. He is currently Chairman and CEO of Silver King Communications, Inc.

From Beverly Hills, Barry Diller began his career in the mail room of the William Morris talent agency after dropping out of college. In 1966, he joined ABC-TV's network programming department as an assistant. As the Feature Films Specialist, he developed the 90-minute Movie of the Week concept that was successfully introduced in 1968. He then became Vice President of Programming. In 1972, he oversaw another programming innovation, the mini-series. *QB VII* was ABC's introductory mini-series, followed by such successes as *Rich Man, Poor Man* and *Roots*.

In 1975, at age 32, Diller was hired away from ABC to head up Paramount Pictures Corporation. His position as Chairman and Chief Executive Officer unnerved Hollywood, where he was viewed as a mid-level TV executive. The decision was hailed, however, when the studio turned out such hits as *Saturday Night Fever*, *Raiders of the Lost Ark*, *Indiana Jones and the Temple of Doom*, *Ordinary People*, *An Officer and a Gentleman*, and *Terms of Endearment*. In March 1983, Mr. Diller's responsibilities expanded to include the presidency of parent company Gulf & Western's newly formed Entertainment and Communications Group. In that capacity Mr. Diller retained operating responsibility for Paramount Pictures, as well as other Gulf & Western subsidiaries, including Simon & Schuster, Inc., Madison Square Garden Corporation and SEGA Enterprises, Inc.

Diller joined 20th Century Fox Film Corporation and in 1985, the Rupert Murdoch-owned company added seven TV stations to its group of holdings, was reorganized into Fox, Inc., and successfully launched the Fox Network with such popular shows as *Married…With Children*, *A Current Affair*, and *The Simpsons*. The film studio saw such hit films as *Home Alone*, *Big, Broadcast News*, and *Die Hard* come to the screen under Diller's guidance.

In late 1992, Diller became the Chairman of QVC Network, Inc. His 1993 attempt to merge QVC with Paramount Communications, Inc. had Wall Street awash in rumors and speculation. The Viacom and Paramount union, with their rich dowries of film, television and cable, intrigued traditional Wall Street. Diller portrayed his bid as striking out in a new direction to accommodate the coming age of interactive communications. He was always seen as the tenacious underdog, digging and clawing to gain any advantage over a hostile board of directors and a formidable foe — Sumner Redstone, chairman of Paramount's preferred partner Viacom.

Diller's struggle for Paramount was his biggest test yet. It was his attempt to break away from the ranks of Hollywood's isolated elite of power agents and studio chiefs and onto an international platform of media moguls like Rupert Murdoch. Even though Diller's bid for Paramount was unsuccessful, he sent a clear signal that he had become a player with the power to put global resources together to acquire a major asset.

Wall Street analysts remarked that determining who won or lost the Paramount battle is a hard call. They commended Diller for his wisdom in refusing to overpay for Paramount. In fact, his $10.8 billion cash-and-stock bid was estimated to be worth $1 billion more than Viacom’s, but Diller refused to provide stock-price protections that were estimated to cost Redstone another $1 billion. Diller’s restraint in refusing to make a final, stunning bid is predicted to strengthen his reputation on Wall Street.

In search of a bigger opportunity, Diller tried to structure a friendly deal with CBS Inc. in 1994. The deal was scuttled by one of QVC’s largest investors, Comcast, when it floated an unsolicited $2.2 billion bid for the CBS television network. The surprise offer caused CBS to drop its proposed merger with QVC, even though it could have used Diller to resolve some of its growing problems. Although the network led the Nielsen ratings for the third straight year, CBS’s prime-time shows suffered a decline with programming that appeals to older viewers rather than to the youth audience many advertisers seek.

Diller’s quest to head a giant media company has suffered two strikes, but he isn’t out yet. He is considered a programming whiz with a vision for the future. Silver King Communications, Inc. owns and operates twelve UHF stations in major markets across the country and 26 low-power television stations in small communities. With the vast numbers of television channels that will be available, there is tremendous space to fill with programming. The people who can produce the best quality programming are going to be the winners. As Chairman and CEO of Silver King Communications, Inc., Diller’s view right now is of a window of opportunities.

u contributed by Diana L. Hollenbeck

Editor's Notes:
Silver King Communications Inc. purchased the controlling interest in Home Shopping Network from Liberty Media Corporation in February, 1996. The move came amid reports that Barry Diller would transform HSN into a new broadcast entertainment network, featuring news, sports, local and national programming, and syndicated shows.

Distance Education

Also called **distance learning**. Educational programs in which student(s) and instructor are separated from one another by some distance. The learning experience is facilitated by transmission of video, audio, data or image information. Methods of transmission range from mailing course materials, to simple video productions, broadcast television, cable television, the public switched telephone network (PSTN) or satellite service. In some instances, several remote locations are linked to a central training site.

The correspondence school was the forerunner of today's distance education. The earliest correspondence schools, offering print-based instruction by mail, first advertised in the early 1700's. In 1840, Isaac Pitman began teaching shorthand correspondence courses in Bath, England, and is now generally recognized as the first distance educator.

This type of education gained popularity around the world, including the United States, over the next few decades. Anna Eliot Tickner — the so-called "mother of American correspondence" — founded the Society to Encourage Study at Home in 1873. Five years later, John Vincent created a home reading circle, which led to the founding of the Chautauqua movement. This influential group's goal was to expand access to education in America.

In the 1880's, Skerry's College and University Correspondence College in the United Kingdom (UK) began preparing students to take exams for post-secondary degrees. The International Correspondence Schools of Scranton, Pennsylvania, started offering technical and vocational courses in 1890. Two years later, William Harper Rainey was named President of the University of Chicago. There he founded the first college-level correspondence study division in the United States and became known as the "father of American correspondence study." By the 1900's, correspondence schools of various types were successful worldwide.

One of the first instances of what is known as distance education occurred in 1874, when Illinois Wesleyan University began offering degrees in absentia. The term *distance education* itself first appeared in a University of Wisconsin catalog in 1892. Fourteen years later, the University of Wisconsin-Extension was founded, and over time has proved to be one of America's premier distance education institutions.

Issues of quality and ethics in this new teaching form were addressed by two early groups. In 1915, the National University Extension Association held its initial meeting to begin accrediting distance education programs. And in 1926, the National Home Study Council addressed the same issue with technical and vocational school programs.

As distance education was gaining ground in Europe and the United States as a viable alternative for students who were geographically remote from on-campus classrooms, it was also flourishing in Australia. Providing education to its sparsely populated areas has been an ongoing priority addressed through various forms of distance education. Schools of the Air have provided children in the outback with radio broadcasts to supplement their correspondence classes. In addition, teachers and students — separated by hundreds of miles — have used two-way radios to interact directly to complete their lessons.

In 1926, the British Broadcasting Corporation (BBC) first proposed a “wireless university” using new technologies, such as broadcast radio and television. Within a decade, educational television broadcasting was a reality at the University of Iowa’s station W9XK, preceded somewhat earlier by the University of Wisconsin’s amateur radio station, WHA. In 1952, the first cable television systems were built in the United States, opening up new avenues for distance education. Also during the 1950’s, Chicago Citywide College began broadcasting telecourses, education presentations delivered via television and videotape. At the same time, Pennsylvania State University began to offer closed circuit classes.

During the next 20 years, as technology changed and support grew, there was widespread change in telecourses and distance education. In 1962, Congress passed the Educational Television Facilities Act, which supported the construction of new educational television facilities. Five years later, Congress adopted the Public Broadcasting Act, which redefined public television and led to creation of the Public Broadcasting Service (PBS) and National Public Radio (NPR) as distribution networks for educational programs to noncommercial U.S. stations. Educational broadcasting also received federal support and monies through this legislation. In the 1960’s and early 1970’s, Canada and the UK founded Athabasca University and the British Open University, respectively. They remain dedicated to a distance education structure that combines print and non-print sources. Each has successfully provided educational opportunities to thousands of students.

In 1972, the U.S. Federal Communications Commission (FCC) ruled that cable television systems must include educational stations in their programming. This ruling helped PBS stations greatly increase their audience and industry stature. In 1981, PBS’s new Adult Learning Service began offering telecourses combining video, text and other elements. Later, PBS introduced the Adult Learning Satellite Service (ALSS), which distributes telecourses and educational conferences to colleges and universities via satellite.

The National Technological University (NTU), formed in 1984, is a consortium of 24 engineering schools offering distance education. Still flourishing today, NTU is a private, non-profit, degree-granting institution headquartered at Colorado State University. With no faculty or campus of its own, NTU broadcasts (via a satellite network) over 5,500 hours of credit and non-credit engineering courses from its 45 participating schools to over 100 sites including locations in Southeast Asia.

In 1986, cable television pioneer Glenn R. Jones launched Mind Extension University (ME/U), a cable television network designed to offer distance education telecourses, including for-credit degree programs, and personal and professional development classes. Others in the industry also have recognized the value of cable-delivered educational programming, and are developing their own programs to meet this need.

In Australia today, the majority of schools — regardless of their location — use radio and television. Thousands of radio programs and hundreds of television programs are produced locally and many are purchased outside the country. The capital city of each Australian state has a correspondence school to help meet the needs of children who cannot attend school for health or logistical reasons, as well as for Australian families who are overseas. The specially designed, family-supervised work is done at home and mailed back to the school for teacher follow-up.

Modern distance education is a rapidly growing field. Because effective communication is essential to all learning, the increasing sophistication of communications technology is making more methods available for bridging any geographical gap that exists between student and teacher . Today, distance education trends worldwide are combining various technological tools to help students at-a-distance have more interaction with their instructors and classmates. This two-way communication is more stimulating for the student and enriches the learning experience through discussion and dialogue. Tools currently in use include computers and modems, cable television, video, audio and video conferencing, electronic mail (E-mail) and so on. With the giant strides being made in technology development, the range of distance education methods will undoubtedly continue to climb dramatically in the years to come.

CAA Research of Wellesley, Massachusetts, conducts comprehensive annual surveys that measure activities and emerging trends in U.S. education. Results from CAA's 1994 survey — with nearly 20,000 educational institutions from primary through post-graduate polled — reveal that nearly 30 million students are currently involved in some form of distance education.

The concept of distance education appeared nearly four centuries ago. In the ensuing generations, it has evolved and prospered as an effective method for acquiring knowledge. Today, with the growing proliferation of facsimiles, interactive video, laptop computers and the like, we may have just begun to experience the first glimmers of the vast potential of distance education.

u contributed by Kay S. Volkema and Susan P. Sanders

Distribution System

A distribution system moves cable television signals from the headend where signals are processed to the geographical areas that receive cable television service.

In cable television, the distribution system delivers cable signals to neighborhoods and communities. It consists of two types of cable: trunk cable, designed to carry signals over far distances, and feeder cable, which connects the trunk cable to residential areas. The distribution process begins after the central signal processing area (the headend) has received television signals from antennas and figured out where they should be sent.

The headend then sends the signal through the trunk cable. Along the way, the signal tends to become weaker, making picture quality poor. Trunk amplifiers stationed periodically along the trunk cable help maintain signal quality by increasing the signal strength. This allows cable customers to receive the best possible reception.

Feeder cables take the signal from the trunk cable and deliver it directly into neighborhoods and communities that receive cable television. This is the cable that runs along residential streets and in backyards of neighborhoods that receive cable television service. It is usually thinner than trunk cable and requires a different kind of amplifier than trunk cable. The job of the feeder cable amplifier, called a line-extender, is to maintain picture quality. Feeder cable may be found either underground or suspended from poles, like telephone wire. In fact, aerial cables often share poles with telephone and power lines. Installers tap into the feeder cable through drop cables to connect the customers' homes to the cable system.

u contributed by Christopher LaMorte

Dolan, Charles “Chuck” F. (1926 –)

American businessman, known for his visionary cable TV programming, he invented a sports and movie service — Home Box Office. Dolan is currently Chairman of Cablevision Systems Corporation.

Chuck Dolan has built his Long Island-headquartered company into one of the largest cable operations in the country, with 2.6 million subscribers in 19 states. Cablevision’s recent pairing with ITT Corporation to acquire Viacom’s Madison Square Garden (MSG) and its entourage of sports and entertainment gives Dolan a near shut-out on New York cable sports programming.

The nearly $1.1 billion acquisition includes the Madison Square Garden cable network, the New York Knicks basketball team and the New York Rangers hockey team, and the broadcast rights to the New York Yankees baseball team. Through Cablevision’s programming arm, Rainbow Programming Holdings, Inc., Dolan already owns MSG’s chief competitor, SportsChannel New York, which carries the games of the New York Mets and Islanders, and the New Jersey Devils and Nets.

The new sports offerings will join Rainbow’s other channels: BRAVO, a national cable service dedicated to international films and performing arts with over 20 million subscribers, and American Movie Classics (AMC), which offers Hollywood’s greatest films from the 1930’s to the 1970’s to its 50 million subscribers. On September 1, 1994, Cablevision’s Rainbow group launched the Independent Film Channel (IFC), the first and only network completely dedicated to independent films. Rainbow is also a partner in Court TV, launched in the summer of 1991, which became a household word over the next few years with the broadcast of such sensational trials as those of the Menendez brothers and O.J. Simpson.

In addition to building Cablevision’s holdings, Dolan is looking to the future of cable and ways to offer more choice to his subscribers. Because Dolan sees the new technologies, like satellite services, creating an inevitable growth of consumer choice, Cablevision is investing in fiber-optic technology to ensure a multitude of subscriber options. But this customer focus is nothing new for Dolan, who first learned about innovative marketing in the late 1960’s.

At that time, cable was used primarily to bring better reception and sound to TV viewers in rural areas. Dolan was grappling with a way to introduce cable TV to New York City. The cost to lay cable under the city streets was expensive and urbanites couldn’t see the point of paying for better reception of what they were seeing for free. That’s when Dolan came up with an idea that would revolutionize television: programming that gave customers something they couldn’t get elsewhere.

Dolan approached Madison Square Garden and made a deal to carry the black-out games of that year’s play-offs for the Knicks and Rangers. For $24,000, and a guarantee that he would buy any unsold seats, Dolan forged a plan that worked. Armed with the confidence that he was on the right track, Dolan put together a movie and sports service called the

Green Channel, then renamed it Home Box Office (HBO). HBO was the first in the industry to schedule commercial-free feature motion pictures on a nightly basis as a draw for cable subscribers. It was launched in 1972 with its first film, *Sometimes a Great Notion.* In 1973, Dolan sold HBO to Time, Inc. and bought the Long Island cable franchise, which became Cablevision.

Dolan and his family control 10 of the 14 seats on Cablevision's Board of Directors. He has come a long way from his Cleveland beginnings as a writer of radio scripts and commercials. He dropped out of John Carroll University and began a sports newsreel business, but found himself strapped for enough money to keep the business going. He traded his customers for a job with a competitor in New York, Telenews.

Dolan has long been seen as an innovator in the industry, launching the first 24-hour regional news cable channel and offering subscribers their choice of which channels they wish to purchase. However, all of this programming comes at a price. While direct comparisons of the fees charged by a particular cable system are difficult to make because of the variety of programming services, consumer advocates and Wall Street analysts agree that Cablevision's customers may pay among the highest fees in the country.

However, Cablevision believes that its average revenues indicate how much people buy, and that they choose to buy more from their operation. The cable industry agrees and considers Dolan a marketer extraordinaire, able to generate revenues in areas others overlook. The industry seems to agree that Dolan deserves these accolades, despite the occasional failure like the TripleCast. The TripleCast were extra-pay packages he and NBC tried selling from the 1992 Summer Olympics.

Such visionary thinking and risk-taking have created ample rewards for Dolan. In 1994, *Forbes* ranked him as one of the 400 wealthiest individuals in America. Married, with six children, he lives an unpretentious life on a five-acre waterfront estate on the northern tip of Oyster Bay, Long Island.

u contributed by Diana L. Hollenbeck

Gutenberg, Johannes Genfleisch (circa 1400 – 1468)

German craftsman and printer, primarily regarded as the inventor of commercial printing and creator of the Gutenberg Bible — the earliest book printed from movable type.

Gutenberg was born around 1400 in Mainz, Germany. In 1430 he relocated to Strasbourg, where he held a number of jobs including goldsmith, mirror-maker, gem-cutter, crafts teacher and policeman. He also entered a printing venture with several partners and began early experiments with wood and metal type.

Gutenberg returned to Mainz in 1448 to found his own press. His moveable-type method used sand molds for casting type, oil-based inks, and redesigned woodcut presses to accommodate the metal-alloy type.

In 1450 he accepted a financial partner, Mainz financier Johann Fust. The relationship ended acrimoniously five years later, and Gutenberg lost the business to his partner through a lawsuit. Fust and his son-in-law Peter Schoffer (Gutenberg’s most skilled employee) then completed the Gutenberg Bible — the famed masterpiece that Gutenberg had begun earlier. A three-volume work in Latin text and Gothic type, it is also known as the 42-Line Bible. Fust and Schoffer also completed the Psalter, considered today to be Gutenberg’s second masterpiece.

There are diverse opinions on whether the loss of this business financially ruined Gutenberg. But with the help of Konrad Hummery, he did set up another press in Mainz and continued printing. In 1465, his contributions were recognized by the German archbishop Adolph von Naussau, who made Gutenberg a member of his court and gave him a pension of sorts.

Johannes Gutenberg died in Mainz in 1468, and his groundbreaking method of movable-type printing endured almost unchanged for five centuries. The Gutenberg Bible is today among the world’s most valuable and venerated books.

u contributed by Kay S. Volkema

DuMont Television Network

A pioneer American television network that broadcast from 1947 to 1955. DuMont's innovative programming included *Ted Mack's Original Amateur Hour*; Bishop Fulton J. Sheen's *Life Is Worth Living*; and *Caption Video*, the forerunner of today's superheroes.

DuMont Laboratories, the parent of the DuMont Television Network, was a research facility founded by Allen B. DuMont in 1931. Technological developments attributed to DuMont Labs include the first movable camera dolly, an improved cathode ray tube, the Zoomar lens camera, the Electronicam camera and the first 20- and 30-inch television tubes.

In 1939, DuMont Laboratories started W2XWV, the beginning of the DuMont Television Network, as a small experimental Passaic, New Jersey, television station. By the early 1940's, W2XWV had been granted a license by the Federal Communications Commission (FCC). The station gained commercial status in 1944 and moved to New York, where it was renamed WABD. In the next two years, the FCC licensed DuMont to also operate stations in Washington, D.C. and Pittsburgh. Other affiliate stations — some sources report they numbered over 175 — would join the DuMont Television Network during the next several years. Officially, it became a nationwide network in 1947.

In its heyday, DuMont showcased many stars of the day and some of the most popular programming. Jackie Gleason, Morey Amsterdam, Ernie Kovacs, Ted Mack, Ernest Borgnine and Dennis James were among its headliners. *The Honeymooners* premiered as a sketch on *Cavalcade of Stars*, DuMont's successful variety show. *Ted Mack's Original Amateur Hour* was born at DuMont. Bishop Fulton J. Sheen's *Life Is Worth Living* on DuMont successfully challenged Milton Berle's popular *Texaco Star Theater. Caption Video* was also a DuMont creation. DuMont's sports shows, such as Monday night boxing matches, were popular with audiences as well. DuMont also featured timely coverage of important news events including the 1954 Army-McCarthy hearings and Secretary of State Dean Acheson's speech on the impending onset of the Korean War. Though marked by innovation, the DuMont Television Network's lifespan was short.

The causes of DuMont's demise are still debated by television historians. There were several contributing factors. NBC and CBS, DuMont's chief competitors, while also new to television broadcasting, were well-established as radio networks. Both profited from their radio broadcasting experience, as well as their long-standing relationships with the era's dominant stars and advertisers. DuMont was experienced in television manufacturing since DuMont Laboratories also produced television sets and transmission equipment. That expertise, however, did not translate to success in broadcasting.

Another factor in DuMont's decline was its turbulent 20-year association with Paramount Pictures, which had purchased stock in DuMont Labs in 1938. For reasons that remain unclear, the studio did not provide necessary support to the struggling network. In fact, not only did Paramount refuse to loan funds to DuMont, but it actively discouraged others from doing so as well. One of DuMont's early executives reported the network operated on such a low budget that scenes were painted on window shades and sets changed by drawing the shades. The FCC, in spite of the tumultuous Paramount/DuMont relationship, regarded the two as under common control. Consequently, Paramount's separate ownership of other television stations prevented DuMont from acquiring additional affiliated stations. This further weakened DuMont's ability to build a viable network.

FCC decisions also had far-reaching effects on DuMont. A 1948 FCC freeze on new television stations was intended to support U.S. television development. The freeze ended in 1952. At that time, most U.S. markets with television stations had only one or two stations. Of these, the vast majority were owned by companies — namely NBC and CBS — that also owned radio stations. According to founder Allen DuMont's testimony before a 1954 Senate subcommittee, FCC-developed post-freeze channel allocation schemes would further strengthen NBC and CBS dominance. Despite DuMont's protests, the FCC's plan was implemented. A year later, in May 1955, the DuMont Television Network announced its dissolution. Dr. DuMont's predictions proved true. NBC and CBS reigned supreme among television networks until the mid-1970's, when ABC finally became a major competitor.

After the demise of the DuMont Television Network, DuMont Laboratories continued to operate the New York and Washington, D.C. stations as the DuMont Broadcasting Company. In mid-1958, the company was renamed the Metropolitan Broadcasting Corporation to avoid negative association with the failed network. In January 1959, Metropolitan was bought and merged with several television and radio stations. The new company was named Metromedia, Inc. There are still physical reminders of the pioneering DuMont Television Network. The DuMont antenna still stands atop the former network's New York headquarters, a 42-story art deco building on Madison Avenue. And only a mile away, DuMont's former studios now belong to the local Fox network affiliate. While the life of the DuMont Television Network was short, its legacy endures.

u contributed by Susan P. Sanders

DuMont, Allen Balcom (1901 – 1965)

American television pioneer and inventor responsible for advancing television technology and for founding DuMont Laboratories, which launched the DuMont Television Network.

Allen DuMont was born in Brooklyn, New York, in 1901. After being stricken with polio at age nine, he began to exhibit an interest in engineering by building radio sets while confined to bed. Despite his physical limitations, Allen gained a reputation in college as a daring athlete by joining the swim team and learning to sail. After receiving his degree in electrical engineering from Rensselaer Polytechnical Institute in Troy, New York, DuMont joined the Westinghouse Lamp Company, where he remained until 1928.

After leaving Westinghouse, DuMont became chief engineer at de Forest Radio Company of Passaic, New Jersey. He founded DuMont Laboratories in 1931 as a base from which to conduct his scientific research and eventually was granted over 30 patents. Among DuMont's inventions were a more practical cathode-ray tube (CRT), a movable camera dolly, the laboratory oscilloscope and the Electronicam camera. Prior to World War II, the DuMont Lab was manufacturing picture tubes and television sets. It expanded its product line following the war.

The DuMont Television Network, which DuMont started in 1947, eventually lost out to ABC as the third network and closed in 1955. During its short existence, however, the network presented innovative programming including quiz shows, religious programs and sporting events, as well as featuring major stars such as Jackie Gleason and Ernie Kovacs.

Allen B. DuMont was a pioneer in television technology and broadcasting. He also foresaw television's future as a multidimensional communication vehicle. As early as 1948, he was writing and speaking about television's potential to educate and enlighten. He prophesied that television would be used to build understanding and tolerance among nations and become an instrument of peace. Allen DuMont died in 1965. During his lifetime, he played a crucial role in television's birth and the beginning of its journey toward fulfilling his vision.

u contributed by Susan P. Sanders

E-mail or Electronic mail

Messages sent through computer networks. Each individual message can be sent to a single recipient or to a group. E-mail is the most-used application on the Internet. Over 25 million E-mail messages will be sent through computer networks in 1995 alone.

E-mail was one of the first applications used on computer networks. Examples of messages commonly sent using E-mail are files, memos, graphic images, sound bites, and transcripts. E-mail may be sent through any type of computer network, including local area networks (LANs), wide area networks (WANs) and the Internet.

E-mail messages are sent based on the protocol of the originating network. Protocols are sets of rules that govern how the network sends information to other sites connected to the network. All networks break the E-mail message into electronically coded data. In most LAN networks, for example, E-mail will go directly from sender to recipient or through a main connection site known as a host. If the message needs to go further, such as in WANs or the Internet, it might be broken up into a series of chunks known as packets. Each packet contains the electronically coded data and the recipient's E-mail address. The E-mail will go through various areas of the network until it reaches its final destination — the recipient's E-mail address — where it will be reassembled to match the original.

There are a variety of programs that can be used to create an E-mail message and/or file. Each has its own way of storing and retrieving data. A computer that does not have the original software usually cannot read files saved in a different program format. To solve this problem, most programs can save documents in an ASCII format. ASCII is a simple computer language containing all letters, numbers, and some symbols (for example: A, C, 1, 5, +, %) found in English text.

After the E-mail reaches its final destination, it stays in the recipient's mailbox until it is ready to be read. The recipient uses a "mail reader" to translate the ASCII or program-based data into a readable form. On the Internet, the most common mail reader is called Multipurpose Internet Mail Extension (MIME). MIME also allows users to attach external files and send them with their E-mail messages.

Each E-mail message is made up of four or five distinct elements. The first two lines contain the addresses of the sender and recipient. Each E-mail address on a network is different. Two examples of E-mail addresses are stevcase@aol.com and president@whitehouse.gov. The first part of each address is the name of the individual who is sending or receiving the message, followed by the "at" sign (@). The next portion of the address is the name and type of the network, separated by a period. There are, in fact, several different types of networks on the Internet. Each has its own three-letter address. The Internet breaks networks into a number of different categories. The most common are .com for commercial networks (for example: America Online, Prodigy, etc.), and .edu for educational sites (University of Colorado, Stanford University, etc.).

The third line is called the subject and is determined by the sender. The subject can be left blank or can give a brief synopsis of the message. Next comes the body, which is the core part of the E-mail. It is the message, file, or other data to be sent. Some networks allow users to put an electronic signature at the bottom of their message. Signatures are designed by the senders and usually include something they wish to let others know, such as their E-mail address, a quote, telephone number, or mailing address.

E-mail messages can be sent to one person or a group of people. Usenet groups and mailing lists are databases of E-mail subscribers who wish to discuss a common topic. Any E-mail sent to the database address can be read by subscribers to the group. Topics for these discussions can be broad (for example, misc.kids, which talks about parenting) or limited in scope (alt.music.amos.tori, which discusses the music of Tori Amos).

Unlike in face-to-face communication, it is difficult to show emotion on a computer screen. Some E-mail users have found a way around that by using symbols or acronyms to convey what they are feeling. Known as an emoticon, this type of expression is quickly evolving to fit the needs of users. Examples include :) for a smiling face, :(for someone who is sad, or ROTFL for “rolling on the floor laughing.”

It is estimated that in 1995 over 25 billion E-mail messages will be sent through computer networks. This number is expected to double every two years and surpass fax use by the year 2000. Businesses are using E-mail to keep in touch with customers, parents to talk with their children, and friends to find out the latest gossip.

But E-mail use does have some detractors. The United States Post Office views E-mail as a potential threat to its service, and is considering ways to charge users for each Internet message they send. Whether or not this will actually happen remains to be seen. Regardless, E-mail will continue to be an important way to keep in touch in the late twentieth century.

u contributed by JDC Editorial Staff

Eckert, John Presper, Jr. (1919-1995)

American engineer and inventor, primarily known for co-inventing the first electronic programmable computer (ENIAC), the first American stored-program computer (BINAC), and the first commercially produced electronic computer (UNIVAC) — all in collaboration with John W. Mauchly.

Born in Philadelphia in 1919, Eckert received his degree in electronic engineering from the University of Pennsylvania and stayed on for five more years as a research associate. From 1942 to 1946, Eckert worked with fellow professor John W. Mauchly at the university's Moore School of Electrical Engineering on a programmable computer without moving parts. Their successful effort — sponsored by the U.S. Army — was called ENIAC (Electronic Numerical Integrator and Computer). ENIAC was almost a thousand times faster than Howard Aiken's Harvard Mark I, completed just two years earlier in 1944. Using 18,000 electronic vacuum tubes and capable of 5,000 calculations per second, ENIAC spawned new terms such as *super brain*, used in association with computers. The U.S. Army used the 30-ton ENIAC for military calculations.

While still at the Moore School, Eckert and Mauchly teamed up again (this time with Hungarian-American mathematician John von Neumann) to add a stored-program element to a computer. At the time, computer programs were separate from the machine; changing them required much effort and many man-hours. The stored-program could be kept in the machine's memory just like data, however, and could be accessed and changed just as easily. Eckert and Mauchly finally developed a stored-program computer in 1949 while running their own company, Eckert-Mauchly Computer Corporation. The new machine was called BINAC (Binary Automatic Computer), and it is considered the first American stored-program computer.

Remington Rand bought Eckert and Mauchly's firm in 1950. The next year, the company introduced the first electronic computer to be commercially marketed, the UNIVAC (Universal Automatic Computer), started several years earlier by Eckert and Mauchly. The U.S. Census Bureau bought the first UNIVAC to compile the 1950 census.

Although J. Presper Eckert, Jr. received more than 85 patents for his electronic inventions, he is primarily remembered for co-creating the prototype for today's digital computers.

u contributed by Kay S. Volkema

Edison, Thomas Alva (1847 – 1931)

American physicist and one of history's most prolific inventors, primarily known for inventing the incandescent light bulb, the phonograph, the first good voice transmitter for Bell's telephone, and producing the first talking motion pictures. His discovery, the Edison Effect, later led to the invention of the radio tube.

Edison was born in Milan, Ohio in 1847. His only formal schooling included a three-month stretch when he was seven, because his teachers did not understand or accept him. His mother, a teacher by profession, successfully took over his education and even allowed him a chemistry laboratory in their basement.

Edison's father ran a prosperous feed and grain business. Although he did not need to work, 13-year-old Thomas took a job as a newsboy on the Grand Trunk Railroad. He simply wanted more money to fund his scientific experiments, and he set up a laboratory in one of the Grand Trunk's cars. In 1862, Edison also began publishing a successful newspaper out of that railcar called the *Grand Trunk Herald*. It covered local, national, and international news, and provided Civil War battle reports. A minor fire in the lab ended his Grand Trunk adventure, during which he'd begun to go deaf.

As a teenager, Edison saved the life of a young child about to be hit by a train and his reward was being taught telegraphy by the grateful father. Astute and mechanical, Edison eagerly mastered telegraphy despite his hearing loss. For the next few years, he worked as a telegraph operator in various cities. Many of his later inventions were in the field of telegraphy.

In 1869 at the age of 21, Edison received his first patent, awarded for a vote counter. Around this time, he also perfected a ticker-tape stock quotation printer for use in stockbroker offices.

From selling various inventions, Edison could finally afford to open his own laboratory and factory in Newark, New Jersey. Several hundred employees helped develop and manufacture his inventions, most related to multiplex telegraphy. During this time, Edison married one of the lab workers, Mary G. Stillwell, and they had three children. In 1873, Edison invented his greatest telegraphic device: the quadruplex telegraph, in which one wire did the work of four. Unfortunately, ill health caused him to abandon the Newark business venture.

Upon recovering his health, the inventor opened another laboratory in Menlo Park, New Jersey in 1876. During the next decade, Edison successfully invented many devices there, including the first good voice transmitter for Alexander Graham Bell's telephone. This breakthrough, a carbon button transmitter, enabled sound to travel over distances of 100 miles rather than several yards. Legend has it that Edison uttered the first "Hello" — the now common greeting — to answer the telephone.

In 1878, Edison invented the phonograph (while working on a faster telegraph repeater) — an invention that made him world famous. His wife Mary died in 1884 and he remarried two years later. With his second wife Mina Miller, he also had three children.

In 1887, Edison moved his lab to West Orange, New Jersey. Five years later, his Edison General Electric Company was merged into the now-famous General Electric Company.

During his lifetime, Edison took out more than 1,000 patents, many of them modifying existing inventions. Some major achievements include the invention of an automatic telegraph repeater, alkaline storage battery, diode vacuum tube, electric pen, electric valve, microphone and mimeograph.

Edison also invented the kinetoscope, a machine or projector that produced moving pictures that could be viewed by only one individual at a time. He produced the first talking motion pictures around 1912 to 1913, by synchronizing his two inventions, the phonograph and kinetoscope. The first movie studio was located in Edison laboratories.

The inventor also discovered thermionic emission, which is called the "Edison Effect." This discovery later led to invention of the radio tube by others.

Thomas Edison's most important and enduring invention was the incandescent electric light bulb (in 1879), which had a life of 40 hours. He also devised the first efficient electric generators to supply his bulbs with current. In 1882, he ushered America into the modern age of light when, in an area of New York City, he illuminated more than a thousand lights, powered by an electric station he designed.

In 1915 during World War I, Edison became President of the U.S. Naval Consulting Board, where he continued his work — which also included torpedo and antisubmarine research for the war effort.

He received national and international recognition for his groundbreaking inventions. Thomas Edison died in West Orange in 1931. Today he is considered one of the greatest inventors of all time.

u contributed by Kay S. Volkema

Electromagnetic Waves

A fundamental energy force in nature, electromagnetic waves include waves that are thousands of miles long and others that are millionths of a millimeter in length. The earth is surrounded by an electromagnetic field (EMF); and in addition to those that occur naturally, electromagnetic waves are also created when an alternating electric current is passed through a conductor, such as a wire.

Electromagnetic waves are the only way to transmit a signal from one distant place to another without a wire. Without electromagnetic waves there would be no radio, television, cellular phones or satellite communications; and there also would not be x-rays to diagnose broken bones or microwave ovens to cook food. Without electromagnetic waves we could not see, because visible light is a small, visible portion of the full electromagnetic spectrum. We can only see electromagnetic waves (light waves) that range in length from approximately 35 millionths of a centimeter (violet) to 75 millionths of a centimeter (red).

Electromagnetic waves have two distinguishing characteristics: *frequency*, which is the number of waves that pass a given point each second, and *length*, which is the distance from one peak of the wave to the next peak.

The first person to measure the length of electromagnetic waves was Heinrich Hertz, a German professor whose experiments proved that electromagnetic waves could be used for wireless communication. The term *Hertz* refers to the frequency of these waves. One thousand waves per second is one kilohertz (kHz), one million waves per second is one megahertz (MHz), and one billion waves per second is one gigahertz (GHz).

The electromagnetic wave *spectrum*, which is made up of all electromagnetic waves, includes cosmic waves that are very short, electrical waves that are very long, and everything in between. High frequency waves can carry more information than low frequency waves, which is one reason why frequency modulated (FM) radio, at 88 to 108 MHz, sounds better than amplitude modulated (AM) radio, at 535 to 1705 kHz.

The length of a wave often determines how far it can travel. High frequency waves are short and, under the right circumstances, can be sent over very long distances. They can pass through the atmosphere to reach communication satellites that orbit the earth. High-frequency radio waves are affected more than low-frequency waves by certain weather conditions, such as rain, snow and fog. Short-wave radios can transmit a radio signal from one continent to another. Low frequency waves are long, do not travel as far and are reflected back to Earth by the ionosphere, a layer of ionized particles that surrounds the earth. This reflection of radio waves enables ham radio operators to “skip” signals very long distances, sometimes several thousand miles. Super low frequency waves are less affected by rain and water and are even used to communicate with submarines while they are submerged.

All electromagnetic waves travel at the same speed in a vacuum, 186,000 miles per second. The frequency does not determine the speed; it only indicates how many waves pass a point in one second. For example, in one second you could see three cars pass you as they travel at a speed of 55 miles an hour. Their speed would be 55, their frequency would be three. In the same time that it took for three cars to go past, one large truck traveling 55 miles an hour could pass. Its speed is also 55, but its frequency is one. Since the truck is longer, fewer of them can pass you in the same amount of time that three short cars can.

Electromagnetic waves travel through air at near the speed of light and do not need a wire to carry them, two characteristics that opened up intriguing possibilities for long-distance communications. One of the first people to see the advantages and uses of wireless communication was Guglielmo Marconi, an Italian inventor and businessman who felt that wireless communication could make him rich. In 1896, he patented a wireless receiver in England; however, few people were interested in having messages transmitted in such a way that everyone with a receiver could hear them.

In the late 1800's, the Greenwich Observatory in England began broadcasting time signals to help navigators who used the time of day to pinpoint their ship's location. However, the earliest popular use of electromagnetic waves for communication was with a device called a wireless telegraph. By 1906 its name had been changed to "radiotelegraph" because the signal radiated in all directions from the transmitter. On Christmas Eve, 1906, Reginald Fessenden transmitted a musical concert, the first radio broadcast. By 1920 the new technology was simply called radio.

Allocation of the radio frequencies (RF), which are a portion of the electromagnetic wave spectrum called the RF spectrum, is done in the United States by the Federal Communications Commission (FCC). Separate frequencies are able to carry different programs because transmitters and receivers can be tuned to send and receive specific frequencies of the RF spectrum. Today the RF spectrum is divided into thousands of different frequencies that the FCC has assigned to be used for certain types of radio communications, including cellular telephones, two-way radio, citizens band (CB) radio, police and fire radio communications, air traffic control, and many others.

Since electromagnetic waves are created when an alternating electric current passes through a conductor, all electrical devices, including wires, motors and light bulbs, generate an electromagnetic field (EMF). The field's strength is related to the amount of current that is carried, its frequency, the length of wire and other factors. High-voltage power lines produce an EMF that some researchers believe can cause health problems in people who live nearby.

Electromagnetic waves of different frequencies are extremely useful, enriching human life with music and stories, bringing news and information from far-away places, allowing physicians to see inside human bodies, and making global communications a reality. While many inventions have made our world seem smaller, harnessing electromagnetic waves traveling at the speed of light has brought people closer together than any other.

u contributed by Paul Stranahan

Electronic Frontier Foundation (EFF)

A non-profit advocacy organization that supports the protection of individual civil liberties in the world of advanced communications technology.

The Electronic Frontier Foundation (EFF) was created in Cambridge, Massachusetts, in 1990. The founders of the non-profit organization were Mitchell Kapor, who started software giant Lotus Development Corporation, and John Perry Barlow, a retired rancher and former lyricist for the Grateful Dead who writes and lectures about communications technology and societal issues.

The Foundation's continuing agenda focuses on ensuring that America's constitutional privacy guarantees extend to computer cyberspace. In addition, it is dedicated to developing a regulatory infrastructure that encourages competitiveness and innovation in the burgeoning electronic communications field. EFF activities include using its in-house technological, legal and political expertise to pursue litigation, dispense on-line legal advice and provide education through both electronic and print publications.

In 1991, EFF opened a Washington, DC office to have a presence where national policy is shaped. Jerry Berman, a civil rights attorney familiar with Washington's inner workings, was selected as Executive Director. Following the move, EFF's donor base grew substantially, and the Clinton administration's enthusiasm for a global information superhighway seemingly created a positive climate for the organization's agenda. The move, however, was not without its detractors.

EFF's relocation to Washington caused uneasiness among some of the organization's on-line constituency, who feared that the organization would sacrifice its principles and become entangled in the business of political compromise.

In August 1994, the Digital Telephony bill was introduced in Congress. It raised a key question facing the industry and caused EFF's internal struggle to escalate. The proposed legislation would have allowed FBI access to encryption technology, enabling the government to decode computer messages and essentially eavesdrop on suspected criminal activity. Such surveillance is commonplace with other communications mediums, including the telephone. Opponents of the bill claimed invasion of privacy. While the EFF was also opposed to it, Foundation leaders felt they had insufficient clout to defeat the bill. Instead, they negotiated privately with the FBI and the bill's sponsors to include moderate increases in the bill's privacy protections.

As a result of EFF's involvement with the Digital Telephony bill, some of the organization's backers were outraged at what they viewed as support of a law that conflicted with the Foundation's basic principles. Others saw the tactics as necessary, but destructive to the bond between the EFF and its membership. In the end, the EFF's Executive Director was dismissed and took several key staff members with him. Founders Kapor and Barlow, while remaining on EFF's Board, also stepped down from their positions as Chairman and Vice Chairman. In the January 14, 1995, issue of *The Economist,* Kapor characterized the episode by saying, "A lot of the heat we took was from people who don't value the idea of pragmatic compromise. Nothing we could have done other than total non-engagement would have been satisfactory to them."

On the other hand, the Foundation has not been without its successes. A federal district court in Texas ruled in favor of EFF's position in a case involving the confiscation of computers containing a game publisher's electronic mail (E-mail). The court ruled that federal regulations, including the Electronic Communications Privacy Act, provide the same protection to computer communications as to telephone communications, and that electronic publishers enjoy the same privacy rights as print publishers.

The Electronic Frontier Foundation's new executive director, Andrew Taubman, appointed after its late-1994 management shakeout, is an outsider to the Washington milieu. While his appointment seemingly signals that the EFF will focus less on political issues, the organization remains committed to protecting personal freedoms and fostering competitiveness and growth among emerging communications technologies.

u contributed by Susan P. Sanders

Electronic Publishing

The use of computers, electronic media, and/or telecommunications to produce and distribute information. Electronic publishing covers a vast array of formats, products, and technologies. Because electronic formats are best suited to providing specific pieces of information, they are evolving into the format of choice for statistics, bibliographies, reference works, and databases.

Some electronic publishers rely on networks and telecommunications systems to distribute their products; other distribute information on "hard" media. Each mode of delivery has its uses: floppies for software, CD-ROMs for software and multimedia, on-line databases for ever-changing information, and networks for instantaneous distribution.

In the pure form of electronic publishing, information is stored on a central computer, and telecommunications systems deliver the information directly to the user's television or computer screen. Today, telephone lines are most often used to transmit the information, but cable TV, microwave, FM radio bands, and satellite transmission also can be used.

Online publishing works well for: specialized information for a niche audience (some scientific or academic journals); voluminous data (U.S. Census data, standards); frequently changing data (stock prices); and
information that is needed immediately (airline ticket prices and software fixes).

Some on-line publishers provide direct access to their products; others rely on electronic networks, service providers, or electronic bulletin boards to distribute their products.

Major on-line players include the Internet, CompuServe, America Online, Prodigy, GEnie, and Imagination; database vendor Dialog Information Services; and Lexis/Nexis parent Reed International.

A less well known type of electronic publishing is television teletext. Information is encoded and transmitted piggyback on the standard television broadcast signal. At the subscriber's site, special equipment decodes the signal, and the information (for example, text for the hearing impaired) is displayed on the subscriber's television.

The second major form of electronic publishing produces hard, or tangible, electronic media: floppy disks, optical disks (CD-Interactive, CD-ROM, Photo-CD), magnetic tapes, removable hard drives, CDTV (Commodore Dynamic Total Vision), and the like. These electronic formats, which can contain huge amounts of data, are good for:
u software;
u large reference works infrequently updated (encyclopedias and some databases);
u archives (public documents, photographs); and
u data-intensive formats (video, audio, graphics, multimedia).

Major players in this field include most software publishers; many major reference publishers, like United Microfilms International and Information Handling Services; general-interest publishers, like Voyager Company; and again, the federal government.

Related to electronic publishing is electronic support for print publishing. Ranging from desktop publishing software to sophisticated imaging systems, electronic tools allow printers to skip basic steps in the traditional print process. For example, printers can produce documents directly from a computer file, without making plates for the printing press. Thanks to electronic tools, publishers can produce a few documents on demand, provide regional or specialized print runs, or transmit computer files via phone lines to a remote printer for printing. These innovations minimize the costs of printing, storing, and shipping books, magazines, and other publications.

Taking yet another step, some print publishers offer their works, in whole or in part, on-line. Users may browse the publication on-line or order an electronic copy of all or part of a newspaper, magazine, journal, or book. In some cases, the on-line version of a publication may be more complete or less expensive than the print version; in other cases, there is no print version of an on-line publication.

Publishers combine many formats and channels to distribute their products. For example, software publishers distribute their software on floppy disk and CD-ROM but distribute upgrades, fixes, and drivers on-line. Many magazines, including *Omni* and *Time,* appear in print and on-line.

Whatever the format, electronic publishing offers both benefits and drawbacks. Electronic formats are flexible, easy to update, and immediately available. They accommodate vast volumes of data and rich formats (video, graphics, sound, multimedia). Electronic formats let users search, retrieve, manipulate, and selectively use data. Finally, by drastically lowering, or even eliminating, the costs of duplicating and distributing information, electronic publishing opens the world of publishing to almost anyone.

But the costs of duplication and distribution do not simply disappear: they are transferred to the user. Users must have a computer (with modem or CD-ROM reader) or a specially equipped television. Online services may charge a monthly membership fee plus per-hour or per-use fees. As more and more print publishers adopt electronic publishing, it remains to be seen how people without electronic access will be served.

Publishers have their own concerns. They worry about losing control over the look and feel of their publications. For example, in some proposed electronic newspapers and magazines, the customer has control over the print font, size of pictures, and other design options. Thus, customers could print out very different looking versions of the same issue of a magazine. In addition, publishers are seeking ways to control copyright infringement, or unauthorized use of their materials.

Unheard of 20 years ago, electronic publishing is enjoying explosive growth. In 1993, CD-ROM publishers produced 3,502 titles with a total of 15 million copies. The Internet has more than 23 million users. Memberships in both CompuServe and America Online have skyrocketed. On the horizon and gaining quickly is interactive television. Experts predict a future in which books, magazines, and newspapers; CD-ROMs and floppy disks; on-line and interactive services; and formats as yet unimagined offer a rich menu of interrelated options to our information-hungry world.

u contributed by Constance Hardesty

Ellison, Lawrence J. (1944 –)

American entrepreneur and business executive who founded Oracle Corporation, a producer of database software; currently Oracle's President and Chief Executive Officer.

In 1944, Larry Ellison was born in New York City. He was adopted and raised by his great uncle, a Russian Jewish immigrant, and his great aunt. Ellison's childhood home was a walk-up flat on Chicago's infamous South Side, perhaps explaining the toughness and tenacity he would later display in his professional life. After high school, he attended the University of Chicago to study math and physics but left before graduation after refusing to take a proficiency test in French. It was the 1960's and Ellison was drawn to that era's promised land — California.

After arriving in what was to become the Silicon Valley, Ellison set out to teach himself to program computers. He joined Amdahl Corporation and there he honed his skills by working on the company's project to build the first IBM mainframe clones. Other programming jobs followed. In 1977, Ellison's life changed dramatically. He mortgaged his home and with his partner, Bob Miner, used the money to found Oracle.

The catalyst for Ellison and Miner to launch Oracle was an IBM research publication that outlined a unique way of managing data called a relational database. At that time, databases required users to specify up-front the different ways that they would arrange and analyze information. The IBM document proposed that databases could be developed that would enable users to organize and evaluate data as it was needed. Concluding that IBM would use this idea to launch innovative — and profitable — products, the two entrepreneurs developed their own database programs. Unlike IBM's, however, their software would be able to run on virtually any computer made by any manufacturer. They beat IBM to the marketplace with the revolutionary software by three years. And so, Oracle was born.

Oracle had tapped a crucial business need — flexible, user-friendly databases. By the 1980's, Oracle had become a huge success — it had found a niche where there was little competition. Ellison, known as one of the smartest individuals in the software business, hired only the most talented and energetic employees for his rapidly expanding enterprise. He encouraged market share growth at any cost.

By the late 1980's, however, Oracle had begun to skimp on pre-release testing and customer service. In 1989, the company released a major product that was riddled with flaws. This, and other business downturns, led to a major reorganization and new management in key positions. Since that time, Oracle has returned to its fast growth mode, however, and is more focused on quality products and ongoing customer support. Although competitors began to catch up during the company's troubled times, Oracle still controls an estimated 40 percent of the data management business. Ellison has remained at Oracle's helm through the good times and the bad. The company's dramatic recovery is largely credited to his sense of humor, vision and willingness to change. Today, Ellison owns 24 percent of Oracle, and with an estimated worth of over $3 billion, he may be the richest man in California.

Ellison's lifestyle reflects the love of Japanese culture that he acquired during business travels to Japan. In fact, his strategy for rapid growth at Oracle during the 1980's was said to be modeled on the Japanese business ethic. Ellison lives in the Silicon Valley in a magnificent Japanese-style home surrounded by three acres of lavish gardens, waterfalls and ponds stocked with Japanese koi. Here he hosts formal tea ceremonies and displays his extensive collection of samurai helmets, swords and armor.

In his leisure hours, as well as at Oracle, Ellison is an adventurer. A fitness zealot, he seeks physical challenges. In 1992, while bodysurfing in Hawaii, he suffered a broken neck, snapped ribs and a punctured lung. The following year, he fractured an elbow while bicycling. In mid-1994, he and professional triathlete Peter Kain held a contest for a fund-raising event. Ellison won the bar dip (lifting oneself on parallel bars) competition with 46 repetitions to Kain's 40. In addition to his other talents, Ellison is a gourmet cook and has taught himself to play the piano and guitar.

In 1990, Ellison was honored as Entrepreneur of the Year by the Harvard School of Business, and he received the Smithsonian Information Technology Leadership Award in 1994. He is a director of NeXT Computer Corporation and a participant on California's Information Technology Council. In addition, he is a member of the board of the Dian Fossey Gorilla Fund and a member of President Clinton's Export Council.

Larry Ellison now has his sights set on the information superhighway. He foresees a future where state-of-the-art computers, televisions, telephones and other devices will link a global web of information and entertainment services. Ellison's vision is for Oracle to take a leading role in developing the software that will lay the network's foundation. With his intelligence, perseverance and track record, few doubt that Larry Ellison will turn his vision into reality.

u contributed by Susan P. Sanders

Editor's Notes:
On February 21, 1996, Oracle Corporation and Verifone Inc. announced a joint venture to develop and market software which will enable businesses to provide secure transactions over the World Wide Web. The software will incorporate Verifone's secure payment technologies and Oracle's Web server software. The new product is expected to provide instant credit card verification over the Internet, allowing real-time purchasing which does not rely on batch processing. The software will also support verification of transactions using electronic debit cards which deduct money from the user's bank account, rather than from a credit card limit. The venture places Oracle and Verifone at the forefront of instant transaction verification, a technology which is vital to the growth of online commerce.

Encryption

A process that encodes data to make it unreadable by unauthorized individuals. There are many different types of encryption, some easy to break and others based on mathematical algorithms that are almost impossible to crack. To decode messages, sender and recipient must agree on a password or common key.

Encryption is an age-old process that dates back to the time of the ancient Roman Empire. All encryption uses a set of codes or ciphers to render data unreadable. To decode the information, the reader needs access to the code. While all encryption methods can technically be broken, some codes are more difficult than others to break. The best encryption software is based on highly complex mathematical equations known as algorithms.

Modern, computer-based encryption software packages require that both sender and receiver know the key, or password, responsible for encrypting/decrypting the message. There are two main types of algorithms responsible for this process.

Symmetric algorithms require that the key be agreed upon and kept secret. In most symmetric-based systems, the key is the same for both the encryption and decryption process. If the key becomes public, encoded messages will be available to anyone who has the code. Data Encryption Standard (DES), the most widely used encryption package, is based on this single-key approach.

Public-key systems involve the use of a readily available key. Anyone can encrypt a message and send it to someone using the public key. A group or individual is responsible for making the key available to anyone who wants to send secured data. To decode the information, however, sender and recipient both have to agree on a private key. The data cannot be decoded using the public key alone. Most public key algorithms are based on the RSA method developed by Rivest, Shamir, and Adelman, attorneys who developed this private key encryption style in the late 1950's.

One of the most talked about encryption packages is Pretty Good Privacy (PGP), created by Robert Zimmerman in 1986. Originally PGP was made available to anyone who wanted it via computer bulletin boards and the Internet. The United States government stepped in and cracked down on this practice, however, fearing that criminals would use encryption packages to hide incriminating data. The government then started criminal proceedings against Zimmerman. It was too late, though, by the time the government stepped in. Despite Zimmerman's protests that he had never distributed the software, PGP was available on many networks, including the Internet, to anyone who wanted it.

The government also hoped to implement an encryption standard based on its algorithm, called Skipjack. Invented by the National Security Agency (NSA), Skipjack would involve the use of three keys, one public and two private. The two private keys would be divided between the National Institute of Standards and Technology (NIST) and the Treasury Department. Anything encrypted by the Skipjack algorithm could be decrypted using these keys.

These agencies hoped that the Skipjack algorithm could be placed on chips that would be put in every communications device made for distribution in the United States. These chips, known as the Clipper and Capstone, caused an uproar in the computer security world. Unlike all other encryption packages, the Skipjack, Clipper, and Capstone algorithms were not made available for public scrutiny. The NSA ordered them classified as military secrets.

Indeed, there are a number of reasons for concern about the Skipjack technology. Civil liberties groups, such as the Electronic Frontier Foundation, believe it violates the Fourth and Fifth Amendments to the Constitution that protect individuals against unreasonable search and seizure and against self-incrimination. Another danger is that the government will prevent any American-based software developer from making money by exporting alternative encryption technology. This would put U.S.-based companies at a great disadvantage in the international software distribution market. Some technical analysts even doubt that Skipjack will work at all. But the biggest danger of Clipper, Capstone, and Skipjack is the potential for illegitimate use of the keys. The government has made no guarantees as to how the private keys will be kept and distributed. It is quite possible that the keys could fall into the wrong hands.

So far, use of the Clipper and Capstone is voluntary. PGP is again available to the American public, but it is illegal to export the software program to other countries. The Clipper controversy is unlikely to die out soon, but for the time being its implementation is on hold.

u contributed by JDC Editorial Staff

ENIAC: Electronic Numerical Integrator and Computer

ENIAC, the first all-electronic general-purpose computer, designed by American engineers John W. Mauchly and J. Presper Eckert, Jr. at the University of Pennsylvania in 1946.

The outbreak of World War II left governments on all sides of the conflict desperately seeking ways to harness technology to their strategic advantage. The United States, as well as the Britain and Germany, wanted to develop a high-speed computer that could handle the large volumes of data needed to develop missiles and aircraft and to plot trajectory tables for navy artillery. The ENIAC computer gave the U.S. the edge it needed in this area.

Begun in 1942, and completed four years later, ENIAC was developed through a collaboration between the University of Pennsylvania's Moore School of Electrical Engineering and the U.S. Army Ballistics Research Laboratory. The machine replaced the electromagnetic relays of earlier computers with vacuum tubes, eliminating moving mechanical parts. But the vacuum tubes created their own physical problems. First, ENIAC contained nearly 18,000 of them and weighed 30 tons, occupying 1,500 square feet. Drawing 160 kilowatts of power, the machine drained enough energy to dim the lights in one section of Philadelphia. The enormous amount of heat the vacuum tubes generated produced numerous machine breakdowns and frequent component burnout.

Despite these problems, ENIAC was 1,000 times faster than its contemporary, the Harvard-IBM Mark I, a mechanical relay-based computer built for the U.S. Navy two years prior to the completion of ENIAC. Operated by a punch-card reader, ENIAC could add at a rate of one calculation every .2 milliseconds and multiply at the rate of one calculation every 2.8 milliseconds. It could perform 357 multiplications and 100,000 total operations per second. ENIAC's memory could handle 20 numbers, each 10 decimal places long. To change a program, however, a programmer needed to change the wiring of the machine.

An Iowa State University professor, John V. Atanasoff, and his graduate student, Clifford Berry, also developed a similar vacuum-tube computer in the 1930's, called the ABC. But his team lost its funding and their work was overshadowed by the ENIAC. In 1973, a U.S. court ruled against the ENIAC patent because of Atanasoff's earlier advances in the use of vacuum tubes for computing.

u contributed by Christopher LaMorte

Expansion Board (also called Expansion Card)

A piece of hardware that can be added to a personal computer to enhance its functionality.

Today, many personal computers have the ability to grow with the user’s needs. By taking advantage of expansion boards, users can add various functions to their computers. Expansion boards are printed circuit boards that fit into openings (called expansion slots) inside the computer console. These slots connect the expansion board with the bus, the pathway on which data travels through a computer. Today’s personal computers usually have between three and eight expansion slots to accommodate various expansion boards.

There are many types of expansion boards. A memory board increases a computer’s memory ability. A sound board enables a computer to play music and other sounds, making it essential for multimedia applications. And, as the world becomes increasingly interconnected via computer modem, expansion boards designed to facilitate communication have become popular. Other types of expansion boards are designed to work with the computer’s video display or peripheral devices (such as an additional disk drives) or to allow additional ports to be added to the computer.

u contributed by Christopher LaMorte

Farnsworth, Philo Taylor (1906 – 1971)

American engineer, inventor and broadcasting pioneer, primarily known as co-inventor of modern, all-electronic television (along with arch rival Vladimir Zworykin).

Farnsworth was born in Beaver, Utah in 1906. He became interested in the concept of television while a teenager. After attending Brigham Young University in Provo, Utah for two years, he co-founded Crocker Research Laboratories in 1926 to study picture transmission. By 1928, he had successfully devised the dissector tube, which helped make television possible. Basically, it was a camera that dissected an image into parts. After the parts were transmitted, their light values were restored, creating a reproduction of the original. The first transmission was of a dollar sign composed of 60 horizontal lines. Shortly after this successful demonstration, Farnsworth filed for his first TV patent. By 1930 he renamed his business, Farnsworth Television, Inc.

In the early 1930's, he filed a complaint with the patent office that Russian-born inventor Vladimir Zworykin had used Farnsworth's ideas in developing similar technology for RCA. After an investigation, the complaint was resolved in Farnsworth's favor. He then licensed the rights to this technology to Zworykin's employer, RCA.

Farnsworth's business underwent several reorganizations and name changes over the years. In 1938 it was renamed Farnsworth Radio and Television Corporation, and later it became part of International Telephone and Telegraph Company (IT&T).

Farnsworth also developed amplifier tubes, cathode-ray tubes, electrical scanners, and a number of other electronic devices. He contributed to the development of radar and vacuum tubes, and researched atomic energy, as well.

Philo T. Farnsworth died in Salt Lake City at age 65. He is known today as the inventor of one of the greatest communication mediums in history: television.

u contributed by Kay S. Volkema

Faraday, Michael (1791 – 1867)

British physicist and chemist, often called the father of electricity for his classical field theory. He also discovered the hydrocarbon benzene and invented the first electric generator.

Faraday was born near London in 1791, and was primarily educated by reading the science books in a bookbinder's shop where he apprenticed. After attending Sir Humphrey Davy's lectures at London's Royal Institution, Faraday persuaded the great chemist in 1813 to hire him as a temporary lab assistant. He soon became Davy's protégé and accompanied him on an 18-month tour of the European continent. There he met many notables and advanced his scientific acumen.

Faraday began studying the magnetic effects of an electric current in 1821. He subsequently discovered electromagnetic rotation and built the first two electrically powered motors. Four years later, he became Director of the Royal Institution laboratory and also discovered benzene — a hydrocarbon used today in industrial manufacture. In 1827, the Royal Institution named Faraday to succeed his mentor Davy as Chemistry Chair.

Continuing his experiments, Faraday discovered in 1831 that a changing magnetic field also drives a current, leading to the development of the electric generator, or dynamo. Considered Faraday's greatest achievement, this discovery of electromagnetic induction influenced James Clerk Maxwell's formulation of the electromagnetic theory of light. In 1833, Faraday introduced his laws of electrolysis, which linked chemistry and electricity.

From 1839 to 1855, Faraday published his theories and discoveries in a series of pamphlets entitled *Experimental Researches on Electricity*. Generally recognized as one of the world's greatest experimental physicists, Michael Faraday died in Hampton Court, Surrey, England in 1867, unaware that his work would indirectly result in the revolutionary invention of radio.

u contributed by Kay S. Volkema

Faxes

Electronically transmitted copies of printed or pictorial documents that travel across telephone lines or through wireless technology from one location to another. The term *fax* is short for *facsimile*. Faxes can be sent from a dedicated fax machine or a computer with a fax/modem to another dedicated fax machine, computer with a fax/modem, or cellular fax receiver. Fax machines connect to standard phone lines, and long-distance fax transmissions are billed at normal telephone rates.

Facsimile transmission has been around since the turn of the century. In the 1920's, newspapers transmitted photographs over slowly rotating drums that used photoelectric cells to scan the material. These early transmissions required that users have matched facsimile machines at the sending and receiving ends, so for years they were primarily used by select groups, such as the wire services, the military and police departments. A few businesses used these early faxes, but the practice didn't become generally popular until the development of sophisticated scanning and digitizing techniques in the computer and communications industries allowed fax machines to communicate over ordinary telephone lines. In 1980, a group of standards were implemented for fax manufacturers that allowed all fax machines to communicate with one another.

How Faxes Work

There are various ways to send a document using a fax machine. In the most common way, a paper copy of the document is inserted in the document tray, the number of the receiving machine is dialed, and when an answering fax tone is received, the pages automatically feed through the fax machine one at a time. In the sending fax machine, a scanner converts the material to be faxed into digital bits, a digital signal processor reduces the bits by encoding the white space into a formula, and a modem (modulator/demodulator) converts the bits into analog signals for transmission over the analog telephone lines. The modem and printer on the receiving fax convert the incoming tones into bits and then back into black and white images on paper.

Fax machine printer systems come in two basic types: plain paper and thermal. Plain paper faxes are printed on the same type of paper used in a copy machine and are either ink-jet or laser printed. The paper in a thermal fax machine is a slick coated paper that comes on a roll. Plain paper faxes generally produce a higher quality copy, but most are limited to receiving only 8 1/2 by 11-inch documents. Thermal paper faxes are cheaper to purchase, but the paper tends to degrade over time and with exposure to light. However, thermal paper faxes can receive odd-size documents, since the paper is on a continuous roll. Most thermal faxes have an automatic cutter that cuts the paper once an entire page is received. The majority of stand-alone fax machines can also be used for photocopying, although the print quality is not as good as with most dedicated copy machines.

Most personal computers sold these days come with built-in fax/modem cards. But fax/modem capability can also be added either externally or internally to upgrade almost any computer. Fax/modems are an ideal way to transmit data directly from one computer to another without requiring a hard copy of the document. Computers equipped with fax/modems can also be used fairly effectively for transmitting a computer-generated document to a stand-alone fax machine. However, computers sometimes have problems receiving documents from stand-alone machines, and they cannot be used to transmit hard copies of documents from other sources (for example, a newspaper clipping) without the document first being scanned into the computer.

Faxes Today
Although fax machines were originally developed for use by businesses, the last few years have seen their inclusion in many homes as well. In 1994, fax machine sales equaled $958 million. Households accounted for 5 percent of these sales. Estimates place the 1995 sales at almost three million units.

Fax machines are now being combined with several other pieces of office equipment for added versatility. As previously mentioned, faxes are now included in most computer packages. In addition, today's fax machines may be packaged with printers, copy machines, scanners, and answering machines. With the development of digital networks, high-speed fax machines are now available that can transmit a page in six seconds, compared to the normal 20 seconds an average machine takes.

As fax use has increased, a new problem has arisen. Hackers and industrial spies have begun stealing sensitive data as it is transmitted. In response to this problem, some manufacturers have developed fax machines with transmission encryptors that scramble the signals so that a receiver not equipped with the correct encryptor will receive only gibberish.

Nevertheless, fax machines satisfy the need for instant communication that is essential for most businesses and has become desirable by the general public, as well. Once considered a luxury, faxes are quickly becoming a necessity in small, medium and large businesses.

u contributed by Linda Stranahan

The Federal Communications Commission (FCC)

Unlike many federal regulatory agencies, the Federal Communications Commission (FCC) was not created for the principal purpose of curbing the excesses of an unregulated industry. In fact, the FCC was created largely at the behest of the fledgling broadcasting industry in order to allocate and standardize the use of radio frequencies so that broadcasting could be a viable business. And it was also assigned the task of facilitating the development of a nationwide, interstate wired telephone network by what were then monopoly providers of telecommunications services.

Changing technology has transformed the business of communications since the FCC's inception in 1934. Television is now provided by wire and by satellite, as well as by over-the-air broadcasting. Telephone service is available on a wireless basis as well as through the wired telephone network. Cable television operators are poised to provide telephone service; telephone companies promise to provide television. American Telephone & Telegraph's (AT&T's) monopoly over long-distance telephone service has long since been eroded, and soon even local telephone service is likely to be provided on a competitive basis.

The FCC has played a role in all these changes: sometimes promoting competition and new technologies, sometimes protecting existing competitors from new entrants. Its mandate to allocate spectrum and regulate communications in a manner that promotes the public convenience, interest or necessity has, from time to time, inspired the FCC to regulate the content of radio and television programming. However, as competition in the radio and television marketplace increases, the perceived need and justification for content regulation has diminished.

Today, digital technology promises an information superhighway offering an unlimited array of new services to consumers from an unlimited number of providers. The FCC's current task is to determine (with legislative guidance from the U.S. Congress) its role in fostering and regulating the development of this national information infrastructure.

Out of Chaos Comes the FCC

The explosive growth of broadcast radio in the 1920's was the primary force that eventually brought the FCC into being. Once technology for transmitting radio became available, hundreds of self-proclaimed broadcasters sprung up around the country, transmitting their programming over the frequencies of their choice. When two radio stations used the same frequency to broadcast to overlapping areas, their signals interfered with each other and neither could be received by listeners. Without assigned frequencies, broadcasters were continually forced to relocate on the radio dial in order to avoid such interference.

By 1927, for example, 38 radio stations were on the air in New York City, while 40 stations were competing in Chicago. But, listeners never knew where to find their favorite programs in either city. As President Calvin Coolidge remarked, "The whole service of this most important public function has drifted into such chaos as seems likely, if not remedied, to destroy its great value." To bring some order to this chaos, Congress enacted the Radio Act of 1927.

The legislation established the Federal Radio Commission (FRC) and gave it certain limited powers to bring some order and stability to broadcasting. The FRC established standardized channel designations on the broadcast frequency band. It shut down portable transmitters and it limited the number of radio stations that were allowed to broadcast at night, when atmospheric conditions extend the areas served by broadcast signals and thereby increase signal interference.

Seven years later, Congress incorporated broadcast regulation into a more comprehensive legislative framework for regulating all aspects of nationwide communications with the Communications Act of 1934. That legislation replaced the FRC with the FCC, which was empowered to regulate all interstate communication by wire *and* radio. The new Commission's jurisdiction thus extended not only to broadcasting, but also to the common carrier provision of telephone and telegraph.

The FCC Stakes Out Its Regulatory Ground

In 1934, telephone service (local and long distance) was, for the most part, a monopoly service provided by AT&T. This monopoly was the result of a "social contract" that it had reached with the states years earlier. In return for exclusive rights to provide telephone service over public rights of way, AT&T promised to provide universal telephone service at reasonable rates.

The 1934 legislation preserved the states' exclusive authority to regulate the provision of *intrastate* (within a state) service by telephone companies and other common carriers. But, it directed the FCC to regulate *interstate* (between states) services. Under the common carrier framework set forth in Title II of the Act, the FCC was required to ensure that rates were just, reasonable and non-discriminatory and that facilities to be built and used for interstate purposes would be in the public interest.

Title III of the Act gave the FCC broad authority to license and regulate the use of the airwaves in the public interest as well. This encompassed not only the regulation of broadcasting, but also the allocation of spectrum for private, non-carrier radio services (such as police, taxi cabs, ships and ham radio operators). Most of the FRC's tasks and powers were included under this Title III jurisdiction.

FCC Structure and Staff

The FCC originally consisted of seven commissioners appointed by the President, subject to Senate confirmation. In 1982, the Act was amended to reduce the number commissioners to five. The FCC is an independent regulatory agency, not an arm of the Executive Branch of government. Therefore, to maintain a degree of political balance in the agency, the Act provides that no more than three of the five commissioners may be members of the same political party.

However, the President does have authority to select a chairman from among the five commissioners. The chairman directs the operation of the agency, and most importantly, controls the agency's staff and agenda. Most of the routine regulatory work of the FCC is performed by its staff on delegated authority, subject to review by the commissioners. While the commissioners themselves generally decide major policy matters and vote on the adoption or amendment of rules, they depend on the staff to identify issues, review the arguments of interested parties and draft recommended decisions.

The staff is generally organized into several "bureaus." Each bureau has responsibility for a particular area of regulation, such as the Mass Media Bureau, the Common Carrier Bureau and the Cable Services Bureau. From time to time, new bureaus are created and old ones are eliminated or merged with redefined areas of responsibility.

While the Act contains some specific requirements, standards and prohibitions to be enforced by the FCC, it also gives the agency broad discretion to adopt any rules and policies needed to implement its general responsibilities. In adopting rules and regulations, the FCC is generally subject to the procedural standards and requirements of the Administrative Procedure Act (APA).

Under the APA, before adopting rules, the FCC issues notices of proposed rulemaking and seeks comments from interested members of the public on the proposed rules. Any rules and policies adopted during such rulemaking proceedings may be challenged in a federal court of appeals and will be invalidated if the court finds that they are unconstitutional, at odds with the Act or considered "arbitrary and capricious."

Broadcasting & Cable TV Regulation Gets Complicated
For many years, it was the FCC's regulation of broadcasting, particularly television, that was most noticeable to the public. The agency was responsible for determining how to allocate spectrum for broadcast television, and its decisions determined the shape of the medium for many years. Of special importance was the FCC's decision to emphasize localism and to increase the number of communities that had access to their own local television stations.

In the early 1950's, television sets were capable of receiving only the 12 VHF channels (channels 2 through 13) that the FCC had initially allocated for use by TV broadcasters. In order to give each community its own stations, without their interfering with each other, the FCC had to limit the number of stations available to most viewers. Only the largest metropolitan areas were assigned more than three stations, and many received only two.

This policy effectively limited the number of viable national broadcast networks to three. It also made local licenses extremely valuable. This forced the FCC to develop extensive and complicated criteria for selecting one licensee from among a large number of applicants for each license. These criteria, based on the character and fitness of the applicants and the programming they planned to carry, were applied to license renewals as well.

Before long, in order to ensure that the recipients of its scarce licenses were serving the public interest, the FCC found itself deeply involved in regulating the content of broadcast programming. For example, it formulated rules and standards requiring licensees to carry certain amounts of particular types of programming (such as children's programming, locally originated programming and news and public affairs shows). It also developed the Fairness Doctrine, which required broadcasters to present conflicting viewpoints on controversial issues of public importance.

To provide this diversity of viewpoints in each community and throughout the nation, the

FCC also adopted rules limiting the number of broadcast stations a licensee could own in the same community or nationally. Added to that, the agency adopted cross-ownership rules prohibiting its television licensees from owning various media, such as newspapers and cable systems, in the same community.

From Spectrum Scarcity to Multiple Channels

By the 1960's, two developments began to alleviate the scarcity of television outlets that had formed the basis for so many of the FCC's rules and regulations. First, the All-Channel Receiver Act of 1962 required that all new television sets be capable of receiving not only 12 VHF channels, but also the other 70 UHF channels (channels 14 through 83) allocated for television broadcasting. Second, the advent of cable television, which escapes interference problems because it delivers signals by wire, realized its capability of delivering at least 12 channels of programming to subscribers. (Today, some cable systems can provide more than 100 channels, and that total may soon be multiplied six-fold or more through the use of digital compression technology.)

Initially, however, the FCC did not view cable television as a welcome supplement to the scarce number of television stations available over the air. Instead, the FCC treated cable primarily as a threat to its broadcast licensees, and it adopted rules limiting the extent to which cable could carry programming that might compete with over-the-air TV broadcasters.

For example, the FCC instituted "must carry" rules that required cable systems to carry all local broadcast stations in their service areas. It adopted "anti-leapfrogging" rules that prohibited cable systems from importing strong and popular broadcast signals from distant metropolitan areas. And, it set up "anti-siphoning" rules that prevented cable systems from providing certain movies and sporting events that might otherwise appear on broadcast television.

While the 1934 legislation and subsequent amendments and changes gave the FCC no explicit authority to regulate cable television, the agency asserted that its authority to regulate broadcast television gave it ancillary jurisdiction over cable (and the Supreme Court upheld this contention). The FCC asserted this jurisdiction not only to formulate rules protecting broadcasters from cable competition, but also to require cable systems to provide both access channels and local origination channels, as well as to oversee and regulate certain aspects of the franchising of cable systems by state and local governments.

Cable Comes Into Its Own

Eventually, the FCC rescinded most of its protectionist measures. It eliminated the leapfrogging restrictions on its own, while the anti-siphoning and must-carry rules were struck down as unconstitutional by federal courts. And once it became clear that cable television was effectively correcting the problem of scarcity of available television channels, the FCC also substantially reduced or eliminated most of the broadcasters' programming restrictions and obligations.

The FCC also eliminated most of its franchising standards and the access and local origination requirements, leaving the regulation of cable substantially in the hands of local authorities. Indeed, by the early 1980's, the FCC had become less concerned with imposing restrictions and requirements on cable systems than with preventing local franchising authorities from imposing too many such restrictions and requirements.

By then, the advent of satellite-delivered programming had transformed cable from a mere retransmitter of broadcast programming in rural areas to a provider of new, alternative programming, even in areas served by several broadcast stations. But the FCC feared that municipal rate regulation and programming requirements were preventing cable operators from investing in new technology and programming, thereby keeping cable from reaching its full potential.

Again, relying on its ancillary jurisdiction, the FCC prohibited local governments from regulating the rates of any cable service other than the basic tier. The FCC also stopped these governments from forcing operators to carry non-broadcast satellite networks on the regulated basic tier and seemed prepared to preempt and prohibit regulation of the basic tier as well. With this regulatory backdrop, the cable industry and municipal organizations agreed on compromise legislation that established for the first time a comprehensive federal framework for the regulation of cable.

Fine Tuning Cable Regulation
The Cable Communications Policy Act of 1984 added a new Title VI to the long-standing Communications Act of 1934. It preserved the cities' authority to require cable operators to obtain franchises, but imposed certain standards and restrictions on the franchising process. This included limitations on rate regulation, franchise fees and programming requirements.

The FCC's role in regulating cable systems was substantially enlarged by the Cable Television Consumer Protection and Competition Act of 1992, which amended Title VI. The 1984 Act allowed franchising authorities to regulate only basic rates, and this, only when a cable system was not subject to "effective competition" as defined by the FCC. Meanwhile, in 1985, the FCC determined that cable systems were subject to effective competition if at least three over-the-air broadcast signals were available in their franchise areas. In effect, this exempted almost all cable systems from any rate regulation.

The 1992 Act reversed this result by redefining "effective competition" to require the presence of another multichannel competitor — a definition that reimposed regulation on most systems. It not only allowed franchising authorities to regulate basic rates in the absence of effective competition, but it also authorized the FCC to regulate the rates of non-basic tiers of service if a subscriber or franchising authority filed a complaint regarding such rates.

Congress gave the FCC the task of establishing standards, to be applied by local governments, for determining whether basic rates were reasonable. At the same time it also established standards to govern the FCC's own determinations of whether non-basic was in fact unreasonable. The agency has, in response, developed extensive and complex regulations governing cable rates and has created a new Cable Services Bureau, with a staff of more than 200, to implement rate regulation and other aspects of Title VI.

Common Carrier Regulation: From Monopoly to Competition
During the first few decades of the FCC's existence, when telephone companies generally provided nothing but telephone service and when AT&T was the sole provider of long-distance service, the FCC's regulation of rates, terms and conditions of interstate common

carrier service received little public attention. But the assumptions that formed the basis of AT&T's social compact have dramatically changed, and the FCC has played a key role in transforming the nature of telephone service.

As telephone companies made increasing use of computers to provide telephone service, they found themselves with excess computer capacity and sought to enter the computer services business. The FCC determined that it made sense to allow telephone companies to use this excess capacity, which would reduce the telephone service costs and rates. But, the FCC also recognized that allowing telephone companies to enter competitive, unregulated markets while providing regulated monopoly phone service presented serious risks. This was especially true where a regulated phone service and an unregulated (computer service) business share certain essential costs and equipment, such as computers.

The FCC's concerns centered around the possibility that a phone company would charge a disproportionate amount of those shared costs to its regulated monopoly service (which are paid for with regulated telephone rates). In effect, the phone company could use higher phone rates in the future to subsidize operations of its unregulated competitive service. At the same time, this subsidy could enable the telephone company to deeply discount its unregulated service, thereby harming or eliminating competition in that unregulated service area.

Therefore, the FCC began an inquiry to develop rules and accounting safeguards that would enable telephone companies to enter unregulated, competitive markets, but not in an anti-competitive manner. Those "Computer Inquiry" rules and standards, which have been reviewed and refined several times, have provided the basis on which telephone companies have been permitted to engage in a variety of "enhanced" and unregulated services.

Telephone and Cable Companies Expand and Compete

One business that the telephone companies were specifically prohibited from entering by the Cable Communications Policy Act of 1984 was providing video programming to subscribers in their local telephone service areas. That prohibition was subsequently held unconstitutional by several courts and, as a result, the FCC is developing ground rules for telephone company entry into the cable television business.

While allowing this, the FCC was also adopting rules and policies allowing new competitors to enter monopoly telephone markets, starting with long-distance service. Consequently, consumers have seen long-distance rates plummet with the introduction of such competition. But fostering the entry of long-distance competitors raised a host of complex regulatory problems, especially before AT&T was required to divest its local telephone companies in 1984.

If long-distance service was to become competitive, how could it continue to subsidize its long-distance rates with revenues from its local phone monopolies? What would be the terms and conditions on which competitive long-distance carriers accessed subscribers through the local telephone companies' facilities? How would subscribers choose and access long-distance carriers?

The FCC developed detailed rules to deal with these issues, while at the same time it began examining ways to introduce other new forms of competition to what used to be monopoly telephone markets. It created rules to allow companies to provide private line services and competitive access services that enable businesses to bypass the local telephone company to reach long-distance carriers. It also introduced wireless “cellular” telephone service and, subsequently, “personal communications service” (PCS). Ultimately, the FCC envisions the elimination of the telephone companies’ local exchange monopolies and an increase in both local and long-distance providers from which consumers can choose.

Out of Convergence and Competition Comes an Uncertain Future

As voice, data and video transmissions all become digitized, the lines between the FCC’s regulation of mass media and telephone services will continue to blur and the competitive forces unleashed by the agency will result in a new information marketplace. Precisely what future role the FCC will play in that marketplace remains to be seen, as Congress and the FCC itself struggle to determine an appropriate framework for regulating — or deregulating — the information superhighway.

u contributed by JDC Editorial Staff

Fessenden, Reginald Aubrey (1866-1932)

Canadian-born American inventor and radio pioneer, best known for inventing amplitude modulation (AM) and broadcasting the first American music and voice radio program.

Reginald Fessenden was born October 6, 1866, in Quebec, Canada. After attending colleges in Quebec and Ontario, Fessenden began his career in Bermuda as principal of the Whitney Institute. He resigned to move to New York and pursue his growing interest in science. There he met Thomas Edison and eventually became Chief Chemist at the Edison Laboratory in 1887. By 1892, Fessenden had returned to academic life. He taught electrical engineering at Purdue University and later at Western University of Pennsylvania (now the University of Pittsburgh), where he also researched wireless communication. Fessenden left the university in 1900 to work for the U.S. Weather Bureau, experimenting with adapting radiotelegraphy for use in weather forecasting.

His interest in voice transmission led Fessenden to develop the theory of amplitude modulation (AM), which involves superimposing electric waves that are vibrating on sound wave frequencies onto constant radio frequencies. This modulates the amplitude of the radio wave into the shape of the sound wave. He would later use this technology to actually transmit voice and music.

In 1902, Fessenden and two financial backers collaborated to establish the National Electric Signaling Company to manufacture Fessenden's inventions. Initially, the company constructed a 50,000-Hertz alternator and then a transmitting station in Brant Rock, Massachusetts. It was from this station that Fessenden used the technology he had developed to transmit the first music and voice radio program on December 24, 1906. Wireless operators at sea and as far away as Norfolk, Virginia, heard Fessenden (the broadcast's sole performer) play the violin, sing *O Holy Night* and recite Bible verses. Within months, Fessenden used the new technology to establish two-way wireless communication between Brant Rock and Scotland.

Reginald Fessenden's other contributions to the development of radio include the heterodyne principle, which enables conversion of high-frequency wireless signals to more easily controllable lower frequencies. Later enhancements to this principle made tuning radio signals increasingly easy and helped the growth of commercial broadcasting. Other inventions credited to Fessenden include the radio compass, submarine signaling devices, the sonic depth finder, and turbo-electric drives for battleships. Reginald Fessenden died in Bermuda on July 22, 1932.

u contributed by Susan P. Sanders

Fiber Optic Cable

A thin glass strand that uses light to transport information such as voice, video or data  .

The possibilities of the information superhighway seem endless. From space-age video telephones and video-on-demand services to home shopping services, individuals will have unprecedented access to all types of information at their fingertips. But to achieve this, information providers, particularly the cable and telephone industries, must lay a strong technological framework. Fiber optic cable will be the core of this framework.

Fiber optic cable is a thin, flexible strand consisting of an inner core of glass (which carries the light) and surrounded by an outer covering called a cladding (which keeps the light inside the core). Instead of transporting electrical signals like conventional wire, fiber optic cable transports pulses of light. In the world of high-speed data transmission, this has tremendous advantages. First, fiber optic cable is much smaller than ordinary cable. Despite its smaller size, however, one strand of fiber, thinner than a human hair, can replace many thousand electrical wires. Second, unlike electrical wire, fiber is not susceptible to electromagnetic interference, so the signal it carries is always high quality. Third, not as many amplifiers or regenerators are needed with fiber optic networks. (An amplifier helps boost the strength of a signal; signals tend to become weaker as they travel through any type of transmission medium. Signals traveling via copper wire or coaxial cable suffer a great deal of this type of signal loss and therefore require many amplifiers stationed along the length of the cable). The fourth advantage of fiber optic cable is its relative safety as compared to copper cable. Because no electricity flows through it, it does not attract lightning nor can it generate sparks like metal wires. That makes it possible to string or lay fiber optic cable in areas where the presence of copper cable poses a potential hazard. Finally, fiber optic cables cannot be tapped as easily as copper wires, making them a relatively secure way to transmit information without fear of eavesdropping.

Fiber optic cable's enormous bandwidth is particularly important to the growth of the information superhighway, because bandwidth determines how much information a cable can accommodate. Coaxial cable, the cable television industry's current standard, has an enormous bandwidth, enabling it to accommodate a large amount of information. Like fiber optic cable, coaxial can support 500 television channels, with additional channels reserved for other services, such as telephone or even videophone. However, the strength of signals dissipates greatly as they travel long distances over coaxial cable. Fiber optic cable, by contrast, maintains signal quality better than coaxial over long stretches.

Long distance telephone companies have used fiber optics for years. The technology has greatly improved their service. For example, the first transatlantic wire carried 50 voices at one time. The fiber optic cable used today can carry 85,000 voices at one time.

Because of fiber optic cable's advantages, various information industries have begun rapidly deploying it. In 1991, 5.6 million miles of fiber optic cable had been laid, mostly by telephone companies. By 1993, that number had risen to nearly 11 million miles.

Cable companies have also been wiring parts of their systems with fiber. By 1993, the cable industry, however, only had deployed 327,900 total miles of fiber optic cable. This figure paled in comparison to the 6.3 million miles that had been laid by regional Bell operating companies (RBOCs) and the 2.5 million miles laid by long-distance phone companies. Smaller local phone companies that are not RBOCs made up the rest of the total fiber optic cable mileage.

Though phone companies have deployed the lion's share of fiber optic cable, the cable television industry has begun to lay it at a faster rate than any other industry. In 1993, the cable industry laid 67.5 percent more fiber optic cable than it had the previous year. By contrast, the RBOCs laid only 27.5 percent more fiber optic cable in 1993 than they had the year before, and long-distance phone companies laid 5.6 percent more fiber optic cable in the same time frame .

The growth of fiber optics coupled with other factors has triggered a convergence between the telephone and cable television industries. Since both will use fiber optics to deliver information, each has the ability to invade the other's territory. With fiber optic cable in place, telephone companies can offer television services and cable companies can provide telephone service (when allowed to by state and federal law). There has also been some talk of power utility companies providing fiber optic-based telephone and cable service because the utilities can use components of their existing power distribution systems — utility poles and underground conduit — to also distribute communication cables to customers.

Because of fiber optic cable's previously higher cost plus the high costs associated with connecting customers to it, fiber optic cable has so far been used only in certain segments of both the cable and telephone industries. Most telephone and cable systems use fiber optic cable in a hybrid network, meaning they use both fiber optic and coaxial cable, with fiber optics deployed only at strategic points.

Over the next several years, fiber optic cable will move closer and closer to the end user. For example, fiber-to-the-node refers to laying fiber optic cable until it reaches an individual neighborhood (a node). Coaxial cable is then used to connect all the homes in the neighborhood to the fiber optic cable. Jones Intercable, a cable television provider, has in fact already begun to lay fiber optic cable in its distribution systems in this hybrid manner. Eventually, cable companies that use fiber optic cable could implement advanced analog and digital services, such as video on demand.

A more comprehensive distribution system would be fiber-to-the-curb, where fiber optic cables are brought to street level, and coaxial cable connects individual homes to the fiber optic cable. Two regional Bell operating companies (RBOCs), BellSouth and Ameritech, have developed fiber-to-the-curb plans because the installation of fiber and conventional copper wire now cost virtually the same. Some have argued, however, that fiber-to-the curb is bandwidth overkill. When used in relatively short segments, coaxial cable has enough bandwidth to carry the digital signals needed for interactive services. Deploying fiber to a group of 500 or so homes (fiber-to-the-node) and then using coaxial cable to connect the individual homes may be a more efficient option.

Additionally, the cost of connecting every American home to a fiber optic network is still high both in terms of money and time. Some estimates predict that it will take 20 to 30 years and cost between $200 and $400 billion to connect every U.S. home to fiber optic lines.

u contributed by Christopher LaMorte

Field, Cyrus West (1819 – 1892)

American businessman who amassed a fortune in the paper business and was chiefly responsible for laying the first submarine telegraph cable between America and Europe.

The youngest of seven sons of a Congregational minister, Cyrus West Field was born on November 30, 1819, in Stockbridge, Massachusetts. When he was 15, with $8 in his pocket and his parents' permission, he left home to seek his fortune in New York. During his first year as an errand boy in a Broadway dry-goods store, he earned a dollar a week, which was doubled the second year. Recognizing that his talents were unappreciated in New York, he returned to Massachusetts and, at the age of 18, became an assistant to his brother Matthew, a paper-maker. Two years later he went into business himself in the same trade.

At 21, Field became a partner in a large New York wholesale paper manufacturing firm and married Mary Bryan Stone of Guilford, Connecticut. Six months later, the firm he had just joined failed and he was left holding the debts. From that disaster, he built Cyrus W. Field & Company. He worked with such drive and determination that his family only saw him on Sundays. By the time he was 33, he had paid off all his obligations and was able to retire with $250,000 in the bank — all of which he had made in nine exhausting years.

Like many wealthy Americans, he took his wife to Europe. Seeking further adventure, he explored South America and crossed the Andes with his friend, Frederick E. Church, a famous landscape painter. In 1853, he happened by chance to meet F.N. Gisborne, an English engineer who was building a telegraph line across Newfoundland. After Field's meeting with the engineer where he politely, but without financial commitment, listened to Gisborne, Field started to examine his world globe and suddenly realized that the Newfoundland telegraph was merely one link in a far more important chain. From that moment, Field became obsessed with the possibility of the trans-Atlantic telegraph. Although Samuel Morse had predicted such a feat, Field was the first to do something about it. He wrote letters to Morse and Lieutenant Matthew Fontaine Maury, founder of the modern science of oceanography.

Maury received Field's letter just after he had written to the Secretary of the Navy on the same subject. Maury had forwarded to the Secretary a report of a recent survey of the North Atlantic which disclosed the evidence of a plateau between Newfoundland and Ireland. Maury had commented in his February 22, 1854, letter that this plateau "seems to have been placed there especially for the purpose of holding the wires of a submarine telegraph and of keeping them out of harm's way." Field could hardly have hoped for better news. When he received Morse's equally encouraging advice, he had only to convince the potential financiers.

In early 1854, Field assumed the responsibilities of the Newfoundland telegraph company. Its debts were paid off, and Field received an exclusive charter for all cables touching Newfoundland and Labrador for the next 50 years. He triumphantly returned to New York. At a meeting held at 6:00 a.m. on May 8, 1854, Field received $1,250,000 in pledges from subscribers and launched the New York, Newfoundland and London Telegraph Company. However, it took another two and a half years of hard work to validate the New York, Newfoundland part of the company's title. Work was delayed for one year because of damage to the submarine cable that was to have spanned the St. Lawrence River; but finally in 1856 the line was opened and the first part of Field's dream had come true.

Field's next act was to promote the new surveys of the North Atlantic by both the British and American navies, which confirmed the existence of the Telegraph Plateau. The encouraging thing about the Plateau was not its relative flatness, but the fact that its greatest distance from the surface was less than 15,000 feet, and submarine cables had already been laid in water this deep. Despite this promising information, however, with the United States heading for one of its periodic depressions, financial support for an Atlantic telegraph cable proved elusive. Field sailed to England in the hope that capital would be less difficult to raise there. He was right, and by the end of 1856 the Atlantic Telegraph Company was organized with £350,000 in its coffers and the financial and material support of the British government. Field then returned to the United States. After great difficulty, he received aid from the U.S. government, which President Franklin Pierce granted on March 3, 1857, his last day in office.

The Atlantic Telegraph Company had 2,500 miles of cable made with seven copper wires twisted spirally to form the conductor. It was covered with three layers of gutta-percha (sap of the sapodilla gutta-percha [latex] tree, which created a waterproof insulation), tarred hemp, and a spiral sheathing of eighteen strands of iron wire. Listening to the recommendation of the technicians to keep in constant contact with the shore, Field set off in August 1857, using two ships. The U.S. ship, *Niagara,* started laying cable from Valentia, Ireland, with one-half of the cable. The plan was to splice the cable mid-ocean to the British ship *Agamemnon's* cable, with the *Agamemnon* then proceeding to Newfoundland. But the cable wasn't strong enough. Just 300 miles from Valentia it snapped and was lost.

A second try was launched on June 10, 1858. This time the two ships would sail to the middle, splice their cables and lay them on their way back to their respective shores. After three tries, 112 miles were finally laid, but then the cable snapped. Buffeted by the century's worst storm, the cable was too damaged to be used. On July 17, 1858, the ships set sail again, and on August 5, the *Niagara* reached Newfoundland at 4:00 a.m. Two hours later, the *Agamemnon* signaled that she had reached Valentia. The revelry was short-lived. On October 20, 1858, after 732 messages, the cable failed.

In 1865, Field tried again. This time the cable was manufactured with four layers of gutta-percha and a spiral armor of ten iron wires, making it three times the size of the 1858 cable. A British cargo ship named the *Great Eastern* was the only ship in the world large enough to carry the 2,300 nautical miles of cable weighing 9,000 tons. Leaving from Valentia on July 23, the *Great Eastern* headed to Newfoundland. After 1,186 miles of cable had been laid, and while the third fault that appeared to be the result of sabotage was being repaired, the cable broke and sank to the bottom.

The determined cable promoters then formed the Anglo-American Telegraph Company, raised more capital and prepared for another try in 1866. With 1,600 miles of new cable that had nearly three times the tensile strength of the old version and with improved cable-laying and picking-up machinery, the *Great Eastern* set sail for the west again. After laying 1,896 miles of cable in 14 days, the *Great Eastern* arrived off Heart's Content, Trinity Bay, Newfoundland, on July 27, 1866. It took two days for repairs to be made to the cable across the Gulf of St. Lawrence to Breton Island so Field could wire New York with the good news at last.

Cyrus West Field was one of the most influential Americans of the nineteenth century and the work he did changed history. Described as a visionary and a chivalrous man, Field's arduous quest to link America and Europe with an Atlantic telegraph cable dominated his life for almost 12 years. His vision alone would not have been enough to achieve his dreams; it was his shrewdness that enabled him to become what would be a millionaire by today's standards by the time he reached his early thirties.

Only 45 years old when success with the trans-Atlantic cable was finally achieved, Field's restless nature roused him to become interested in the possibility of laying the Pacific cable; and later, born gambler that he was, he bought controlling interest in the New York elevated railroads and two newspapers. During his lifetime he amassed three separate fortunes and lost each one. He died a pauper in 1892.

u contributed by Diana L. Hollenbeck

Financial Interest and Network Syndication Rules

The financial interest and network syndication rules (fin-syn or FISR) were adopted by the Federal Communications Commission (FCC) in 1970 as part of its regulatory efforts to curb the power of the then three major national television networks.

A syndicated program is one that is sold to individual stations, station groups or cable networks, in contrast to a network program, which the network produces or purchases and distributes to its affiliated stations for broadcast. Some syndicated shows, such as *Oprah* or *Donahue*, are produced especially for syndication and are not distributed by the networks. Other syndicated shows, such as *I Love Lucy* or *Roseanne,* are series that originally aired over a network.

A television show goes through a lengthy and expensive process of conception, approval, production and scheduling. If a network accepts a program, it may license the show from the producer, paying 80 to 90 percent of the production company's cost. (The license fee does not cover all costs partly because the network has also incurred expenses in the process.) The license agreement may allow for two airings per program The network tries to recoup its costs by selling advertising during the program. The producer hopes that the show will be successful so that the network will continue to buy the series.

If the show is successful and runs for at least 100 episodes, it becomes a prime candidate for the syndication market. And that is where the producer — who can sell the program and keep all of the revenues — can realize substantial profits.

In the 1960's, the networks, not the program producers, largely controlled the sale of television programs for syndication. In licensing programs from producers, the networks would reserve the rights to the profits from syndication. Charges were made that the networks would prevent studios from entering the television industry by not buying products from them. The networks were also accused of warehousing shows or not putting them into the syndication market once they were off-network, thus preventing independent stations from competing with programs on network affiliates or having access to former network shows.

Fin-syn was adopted in 1970, after almost 12 years of FCC and congressional study and investigation of network practices. The rules adoption was prompted by the unique position then enjoyed by the three major national networks as operators of the only video distribution systems serving the nation through their networks of affiliated stations.

The financial part of the rules prohibited the networks from having any financial interest (other than the right to show the program on the network) in the exhibition, distribution or other commercial use of television programs which they did not produce. The syndication portion of the rule prohibited the networks from engaging in the business of program syndication and from reserving rights to revenues or profits from syndication. (A small exception permitted the networks to syndicate the few shows they owned in foreign markets only.)

In December 1974 the Department of Justice filed suit against the three major television networks, charging them with combining their owned and operated television stations and their affiliated stations to monopolize prime time entertainment programming. These cases were settled by consent decrees which imposed restrictions essentially identical to fin-syn.

The fin-syn rules were designed to create more opportunities for studios and independent program producers and syndicators, and they did give many production houses of all sizes an entrance into the television programming business. The networks, not surprisingly, objected to fin-syn's restrictions on their business opportunities.

In 1982, the FCC began proceedings looking toward eliminating fin-syn. Congress also got into the act, holding hearings and considering legislation on the issue. Mainly as the result of congressional pressure, the FCC proceedings remained in limbo until 1990. At that point, acting in response to the request of the Fox Broadcasting Network (Fox), the FCC began new proceedings on the rules. As a result the FCC modified fin-syn and, after court proceedings and further administrative proceedings, the FCC finally decided to eliminate most of its provisions. Fin-syn is scheduled to be completely eliminated by the end of 1995.

Fin-syn never applied to the Fox network (because it did not qualify as a network under the FCC's definition of the term). Nor did it apply to the new United Paramount Network (UPN) or the Warner Brother Television Network (WB). With the elimination of fin-syn and the introduction of new technology and delivery methods, the three established networks and any other company seeking to enter network television can explore business options beyond television network programming.

u contributed by JDC Editorial Staff

Fleming, Sir John Ambrose (1849 – 1945)

English electrical engineer, physicist and author, primarily known for his pioneering contributions to telephony, wireless telegraphy and electric lighting. He also produced the first vacuum tube, crucial to the development of radio and television.

Fleming was born in Lancaster, England, in 1849. He taught electrical engineering briefly at the University of London and for 41 years at London's University College. During this time, he was deeply involved in and made important contributions to the new and developing technologies of his time, including the telephone and the wireless telegraph. Fleming also pioneered the use of electricity for large-scale lighting and heating.

In 1904, while serving as a technical advisor to the Marconi Corporation, Fleming conceived the notion that a device producing the Edison Effect (discovered by Thomas Edison) could effectively be used to detect wireless signals. He called this new vacuum tube (containing a cathode and an anode) the "Fleming valve"; today we call it the first electron tube or the thermionic valve. It proved to be crucial in radio's development and contributed to the advancement of other areas of broadcasting.

Fleming went on to publish many scientific works, including *The Principles of Electric Wave Telegraphy and Telephony* (1906), *The Propagation of Electric Currents in Telephone and Telegraph Conductors* (1911) and *Fifty Years of Electricity* (1921).

For his outstanding scientific contributions, Fleming was knighted in 1929. Sir John Ambrose Fleming died in 1945 at the age of 96.

u contributed by Kay S. Volkema

Floppy disk

A disk coated on both sides with magnetic material that can record and store computer data. Floppy disks are one of the most common computer storage media. Unlike other types of computer memory, floppies are portable, reusable, and can create an almost permanent record of data.

Except for CD-ROMs and other optical disks, most computer disks store data magnetically. Each type of computer (for example: Apple, IBM, UNIX) has its own way of storing binary language. Binary language is made up of only two states (for example: on or off, one or zero) that are combined in many different ways to record data by the computer. Each disk must be formatted to store and read the specific binary language of the computer system. Formatting a disk is a relatively simple process that allows the data to be saved on the disk in an orderly manner. Disks are logically broken up into two areas of memory. These two sections make up a map that the disk drive can write to or read at a later date. One section is made up of sectors, each looking something like a slice of pie. The other is made up of tracks that look like concentric circles.

To save information on a floppy disk, the user inserts the disk into a floppy disk drive. The disk presses against a group of levers to expose the magnetically coated mylar disk. Other levers move two read/write heads towards the disk on both sides. Each head is made up of tiny electromagnets that create magnetic pulses to change the polarity of the metallic particles found on the disk's coating.

While this is happening, the drive's circuit board is receiving instructions from the controller board for reading or writing and saving data to the floppy disk. When information is to be saved onto the disk, there is a way to double check that the disk is okay to write on — that is, the circuit board makes sure no light is coming through one corner of the disk's housing. If the movable window on the corner of the housing is open, the light will be detected by a photodiode on the opposite side of the disk. In this way, the circuit board will know that the information recorded on the disk is "write-protected," meaning permanently stored, and will not allow new data to be recorded over it.

If the window is in the not-write-protected position, the circuit board next translates instructions and the read/write heads start to move. A motor below the disk starts to spin. It is connected to the floppy disk by a notch and the disk starts to spin as well.

A second motor, called a stepper, moves a shaft with a spiral groove cut into it. The stepper motor can turn a specific amount in either direction according to instructions given by the circuit board. Arms connected to the read/write heads come to rest inside the shaft's groove. As the shaft turns, the arms move back and forth. The read/write heads move into the proper position on the disk.

Finally, as the heads settle into the correct position, electrical impulses create a magnetic field in one of the heads. If the heads are reading information, they react to the magnetic fields on the disk.

When the electronics are reading the disk, they send the data from the disk drive through the computer's basic input/output system (BIOS). The BIOS often places the data in random access memory (RAM), where it can then be read by a software program and processed or displayed on the computer's monitor.

Today floppy disks come in two sizes. The older size is 5.25-inch square .
Another difference between the two types of disk is the amount of data each can retain: the 5.25-inch floppies can hold about 700 kilobytes, whereas the 3.5-inch disks can store about 2.88 megabytes, depending on the type and format of the disk.

Compared to other types of storage disks, the cost per bit stored on floppies is very low. In addition, floppies weigh much less than hard drives and are very portable, since several 3.5-inch disks can easily fit in a shirt pocket. Due to these reasons, floppies have become a standard in data storage.

Floppy disks do have two major disadvantages, however. First, they can be corrupted or destroyed by outside variables, such as magnetic fields, dust, food particles, and liquids. If any of these substances touch the disk's coating, information held on the disk may be destroyed. Floppies also have a shelf life similar to audio tapes. Eventually they will wear or fade out and need to be replaced.

Second, as computer programs become more and more complex, floppy disks may no longer offer adequate storage capacity. They are already losing ground to competition from recordable CD-ROM (Compact Disk-Read Only Memory) for storage, although some CD-ROMs can only be recorded on once. Until this media advances, floppies remain one of the most popular storage methods for the average computer user.

u contributed by JDC Editorial Staff

Fox Broadcasting Company (Fox)

Headquartered in Beverly Hills, California, Fox Broadcasting Company, known as FBC for a short time and then simply as Fox, is America's fourth national television network. While other companies have tried to break the oligopoly of ABC, CBS and NBC, no one succeeded until Rupert Murdoch and Fox.

If one thinks of the three established networks (ABC, CBS and NBC) as the senior citizens of the television world, the younger networks, Warner Brothers Television Network (WB) and United Paramount Network (UPN) are the toddlers. That leaves the Fox network as a fresh, full-of-life adolescent. It's the company to watch, the one to catch up with. Fox is the network that the upstarts, WB and UPN, will pattern themselves after.

William Fox is the largely forgotten man who started it all in 1910. Fox, a Hungarian, was the eccentric man who owned the Fox Film Corporation until he was forced out in 1930. In all the years William Fox ran his company, it was successful. Without him, it wasn't. In 1935, the only way to save the company was to merge it with the smaller Twentieth Century run by Darryl Zanuck. The new company was called Twentieth Century-Fox.

Ten years before, William Fox had taken the company public. But in 1981 it went private again, engineered by then-Denver oilman, Marvin Davis.

By the mid-1980's Davis and Barry Diller . He rescued Twentieth Century-Fox with much needed cash in return for 50% ownership.

Soon there were talks with Metromedia, a company that owned seven unaffiliated television stations in some of the country's largest television markets. (Actually Metromedia consisted of seven stations prior to Murdoch's purchase. One station was sold before the sale. Murdoch then bought another station at the same time he bought Metromedia and linked it to the Metromedia outlets. The Metromedia purchase is often listed as either six or seven stations.) Diller, as head of the studio, and Murdoch, as a part owner, were interested in buying the stations. Davis, the other owner, wasn't interested in the acquisition, however. So, in a matter of months Murdoch, with Diller's assistance, purchased the stations, bought out Davis, and became a naturalized citizen of the United States.

Meanwhile, in the late 1970's and early 1980's, many changes had been taking place that would allow for network expansion: programs were routinely fed to stations by satellite transmission instead of over expensive telephone lines; the Federal Communications Commission (FCC) went through de-regulation and the responsibilities of the agency changed; an increase in FCC station licensing took place; and the industry became more interesting and profitable for investors. All of these changes, plus Murdoch's moves, made a fourth national network a realistic possibility.

Diller and Murdoch set the planning wheels in motion. In 1985 and 1986 they met with various prestigious television and film creators and producers. The biggest attractions for these people, as the plan for a new network was unveiled, was Fox's willingness to pay licensing fees commensurate with those of the existing networks, and its guarantee of an entire season of shows and complete artistic freedom. Although just a few years later Fox executives would reconsider these platforms, the enticements certainly caused many in the industry to pay attention to the new kid.

Murdoch made his plans for a fourth network publicly known on January 5, 1986. Staff was hired; job descriptions were written, rewritten and lumped together; and in March of 1986, the name of the Fox Broadcasting Company was announced. For nearly a year it was known as FBC. It was ad agency Chiat/Day of Los Angeles that suggested the network trade on the highly recognizable name of Fox.

On October 9, 1986, *The Late Show Starring Joan Rivers* aired on 95 stations. Success for this show was never to be, but FBC was finally on the air. The plan was to concentrate on a single evening of prime time in addition to the Rivers show. The network would make that one night, Sunday, a solid, competitive night before going on to the next. Fox's first night of prime time was ready on July 11, 1987. The feature show, *Werewolf,* beat ABC and CBS in the ratings in both New York City and Washington, D.C.

Fox's somewhat rebellious nature and Murdoch's interest in the industry surfaced in many ways. For instance, Fox made an early unsuccessful attempt to get the National Football League's (NFL) *Monday Night Football* from ABC in 1987. Then Fox successfully won the rights to air the Academy of Television Arts and Sciences' Emmy awards for three years. The network continually pushed for unusual, often controversial, programming. While Fox didn't want to be a network by FCC standards, it did want to command network-type ad dollars. Legitimate, solid ratings that would substantiate advertising dollars became the Fox goal. After many discussions, the new network convinced the A.C. Nielsen Company, one of the largest TV rating service companies, to include Fox in the overnight ratings provided for the country's largest markets so advertisers and agencies could chart for themselves the growing strength of the fourth network.

From the outside it looked good at Fox, a company of rebels who seemed to know what they were doing. Under the surface, however, there was a lot of fighting, tension and distraction.

In a stroke of good fortune for Fox's programs, the screen and television writers went on strike during the summer and early fall of 1988. Once the season of established network reruns had run its course, viewers found another option — Fox. The Fox shows, although also reruns, were new to the majority of Americans, who found some of the programs interesting enough to continue watching. At the end of November 1988, with the strike finally over, Fox scored its first 10 rating with *Married…With Children.* So 1988 became Fox Broadcasting Company's first profitable year.

Obviously, profitability was something Fox executives planned for and expected. While success took longer than the network wanted, most outside critics never thought a profitable year would be possible for the new broadcaster which still wasn't even a true network yet. (The FCC defines a true network as an entity that broadcasts at least 15 prime-time hours each week to at least 25 stations in at least 10 states.) However, Fox had good reason to avoid true network status at the time. Its non-network standing enabled

Fox to avoid the FCC's financial and syndication restrictions. Fin-syn rules limit a network's right to *fin*ancial interest in programs it airs (except for the very few it is allowed to produce) and to *syn*dicate any programs in the United States, thus *fin-syn*. Fox's parent, Twentieth Century-Fox, was a big player in production and syndication and didn't want to give up that highly lucrative source of income.

Fox also used its non-network status in another profitable way. Network-affiliated stations weren't allowed to broadcast previously-aired programs in the half hour before prime time. Since Fox wasn't a true network, the company told buyers that they could air Fox's syndicated shows in that desirable time slot. The extra exposure and credibility for Fox-associated shows helped advance its popularity with affiliates and audiences.

With good ratings in 1989 and providing substantial competition for the other networks the two nights it was on, Fox was ready to make the leap to nights three and four.

As Fox inched closer and closer to becoming a true network, the company applied to the FCC for a waiver of the fin-syn rules. In 1991 the FCC relaxed many restrictions and, although many studios were not happy about it and vowed to fight it, the remaining fin-syn rules were scheduled to be lifted in late 1995.

By the mid 1990's Fox was a steady, strong seven-nights-a-week competitor. The top executives retreated somewhat in their enticements to producers, but the rebel spirit was alive and well at Fox and embodied in Fox-type programming. The network pushed the limits with younger, hipper offerings. Fox aired the first reality-based shows. It aired season premiers in August when the other networks were still airing reruns. The network tried anything different.

In mid-1994 Murdoch invested in New World Communications Group, which consisted of 12 network-affiliated stations in large markets, that all became Fox affiliates. This left ABC, NBC and, particularly, CBS scrambling. Syndicators, which all have a clause regarding affiliation in their contracts, were also in scramble mode throughout the summer and fall of 1994. When Murdoch stuck his toe in the pool of big-time networks, he caused a tidal wave. Twenty-three metro areas of the United States were affected by Murdoch's acquisitions.

In late 1994 Murdoch paid a record $1.6 billion to broadcast the NFL's Sunday National Football Conference (NFL) games. This ended CBS's 38-year relationship with the NFL and caused a hiring binge at Fox. Many high-profile sports announcers, producers, directors and camera people defected from CBS. Fox's critics had a great time predicting failure, based on their assertions that Fox under-served many markets and wasn't available in many others.

In fact, Fox was still programming fewer hours per week (generating lower revenues and ratings than the established networks) and still wasn't offering daytime or news coverage. A stronger signal in specific markets and NFL coverage on Sunday were to help create a giant leap in respectability. Another notch in Fox's legitimacy belt came from Brandon Tartikoff. Tartikoff, a former NBC programming wizard, was linked to Fox by way of New World Communications Group. In 1994 New World bought Tartikoff's production company, so he was now providing programming for Fox and other networks.

If you are not a legitimate threat to competitors, those competitors tend to ignore you. Once a true threat is perceived, those competitors spring into action and try any means to block your success. Once ABC, CBS and NBC started crying foul to the FCC and anyone else who would listen, Fox knew it was onto something. Once the ratings came close to and even, in some cases, surpassed the network numbers, Fox management knew that the public had found the new network. Additional upstarts and renegades will always threaten, but the United States is now without a doubt at least a four network country.

u contributed by Michele Messenger

Carey, Chase (no dates available)

American businessman and television executive, currently Fox Broadcasting Company's (Fox) Chairman and Chief Executive Officer (CEO). When named to the Chairman and CEO position in July 1994, Carey's duties included leading the Fox network, Fox Television Stations, Inc., Twentieth Television's domestic syndication unit, and cable channel fX.

In 1976 Chase Carey received a bachelor's degree from Colgate University and then went on to Harvard Business School, graduating in 1981. Carey's television industry career included a stint at Columbia Pictures from 1981 to 1987, where he gained experience in the pay/cable, home entertainment and international divisions.

Carey came to Fox, the fourth American television network, in 1988. After serving as Chief Financial Officer for four years, he became Chief Operating Officer (replacing Barry Diller) in 1992. Management and expansion were his goals.

When Fox Chairman Lucie Salhany resigned in July of 1994, Carey was CEO Rupert Murdoch's next logical choice for the position. Indeed, Murdoch re-organized some responsibilities to better suit the company as well as the executive. While some affiliates voiced concern over Salhany's departure and the administrator Carey's appointment, Murdoch gave him his full support.

Carey had a front-row seat at and participated in Fox's early, exciting events: acquiring the National Football League's conference television rights and the New World Communications Group acquisition. New World, a 12-station group, was acquired by Murdoch in May 1994. These 12 stations all left their network affiliations to become Fox stations, causing a country-wide station affiliation switch. Reportedly Carey and Preston Padden, then a Fox Divisional President, helped Murdoch in the staggering acquisition.

As Carey stepped up to the new job and new responsibilities at Fox, he found himself in a challenging position. Although Fox had gained some decided respect from producers, ad agencies, advertisers and the audience, there were two new networks being planned for the upcoming season, the network had NFL games to produce, it needed to boost affiliation coverage and explore a news division, and the Federal Communications Commission (FCC) was once again asking questions about the legality of Murdoch's ownership. (Murdoch became a naturalized citizen as he embarked on the Fox adventure and even though the FCC approved his ownership, competitors kept the issue in front of the Commission.)

To date, however, Chase Carey has expertly managed to keep the network right on track.

u contributed by Michele Messenger

Federal Communications Commission Frequency Auctions

In 1994, the Federal Communications Commission (FCC) held the first auction of radio frequency licenses. In a series of complex auctions that ran into 1995, the agency sold licenses for various spectrum frequencies that could be used for a variety of wireless services, including electronic paging, cellular telephones, interactive video and data services, and personal communication services.

Prior to 1994, licenses for broadcast radio, television and cellular services were either given to applicants free of charge or distributed using a lottery format. Occasionally, the FCC would also grant pioneer preference licenses to companies to promote technological innovation or finders preference licenses to encourage the full use of a portion of the spectrum. To encourage the development of cellular telephone services, pioneer preference licenses were given to regional Bell operating companies (RBOCs) and other local phone companies in 1984. Additional companies received cellular licenses using the lottery method of distribution. By 1994, 13 million people had cellular phones and 28,000 people were signing up each day for cellular service. By 1995, the number of subscribers had climbed to 25 million people, who were spending over $15 billion a year for service. The cellular phone business was profitable, and more companies wanted to get into it, but allocation of additional frequencies had to be completed first.

In September 1993, the FCC announced that it would auction licenses for a variety of frequencies that could be used for analog and digital communication services. In November of that year, Nextel Communications bought licenses for 2,500 radio frequencies from Motorola for $1.8 billion. The value of these frequencies, which had been used by taxi drivers, truckers and police walkie-talkies, was enhanced when technological advancements enabled them to be used for specialized mobile radio (SMR). SMR is a digital service that covers an area 25 times larger than analog cellular phones. Nextel's new frequencies gave it the potential to serve 180 million customers in 21 states, a customer base three times the size of the largest cellular company at the time, McCaw Cellular Communications. This sale of licenses proved that, as a resource, the radio frequency (RF) spectrum had considerable value.

The fast growth of the cellular market, coupled with the purchase price of licenses for SMR, helped to set the stage for the multibillion dollar FCC auctions.

These first-ever FCC auctions were designed to ensure that the resources ended up in the hands of people who would value them the most, not just large telecommunications companies. The FCC also felt that auctioning the spectrum would speed the licensing process by 50 percent and bring the services to the public faster than with the traditional licensing application process, which often took at least three years to complete.

Rules and Regulations
To ensure that the FCC goals were possible, extensive rules and regulations were formulated to qualify bidders and conduct the bidding process. Bidders were divided into five groups. An open group included large telecommunications companies. Four other groups were classified as designated entities (DEs) consisting of entrepreneurs, small

businesses, rural telephone companies and minorities.

To qualify for the entrepreneur group, a company had to have revenues of less than $125 million and assets of less than $500 million. In addition, there were restrictions on the amount of control a large business partner could have on the entrepreneur company and the assets of the large company that were available to its entrepreneur partner.

To qualify as a small business, a company's revenues could not exceed $40 million for the three preceding years. Revenues included those from affiliates and other entities that held interest in the small business bidder. An option for small businesses was to form a small business consortium. The total revenues of the consortium could exceed the $40 million cap if each individual small business in the consortium was under the revenue cap. A consortium could not include any members that would be classified as large businesses.

Businesses in the minority category had to be 50.1 percent owned by minorities and/or women, and the group that controlled the DE had to be made up of minorities and/or women. Minority groups included women, Blacks, Hispanics, American Indians, Alaskan Natives, Asians and Pacific Islanders; however, all members had to be U.S. citizens. Minority businesses had to fall within the revenue and asset restrictions set for the entrepreneur group.

To qualify as a rural telephone company, a local exchange carrier could have no more than 100,000 access lines. Rural telephone companies could qualify in either the entrepreneur or small business category and could also form a consortium with other rural telephone companies or non-telephone companies.

For each of the four groups, the FCC formulated other extensive rules that applied to ownership, investors and management.

Qualifying for participation in the auctions as a DE entitled the bidder to special considerations. For example, entrepreneurs and small businesses received bidding credits that reduced the final cost of the license. A small business received a credit of 10 percent, a minority business a 15 percent credit, and a small business that was minority-owned could receive a combined credit of 25 percent. Although the rules allowed all bidders to pay their bids in installments, some DEs also qualified for reduced interest rates and flexible payment plans.

Regardless of type of group, each bidder and its affiliates were limited to 40 MHz of personal communication services (PCS) spectrum in any geographical area and 45 MHz of spectrum for commercial mobile radio services.

In addition to the above rules and their numerous extensions, the FCC set aside licenses for frequencies that could only be bid on by the DEs. All of this was done to ensure that there would be competition for the licenses and competition in the marketplace once services were available. FCC rules regarding anti-trafficking restricted the buying and selling of licenses after the auction. For entrepreneurs, the time limit was five years, with some exceptions, and others had to hold onto their licenses for three years before they could sell them. This rule prevented a company from bidding successfully, then reselling to a large company and circumventing the FCC intent to foster competition and multiple service providers.

The Auction Process
When Congressional approval was given to the FCC in 1993 to hold the auctions, Congress allowed a five-year time period within which to try the auction process; however, the FCC will attempt to complete the majority of the auctions by the end of 1995. Congress also required that the auction proceeds be used to reduce the federal deficit.

Anticipating a series of complex auctions involving multiple bidders for each license, numerous rounds of bidding, and thousands of channels in hundreds of geographical areas, the FCC decided that the bids for most of the individual auctions would be handled electronically. Computers were used to present and display bids and ensure that each bidder would have instant access to each bid.

The auctions were structured by game theorist consultants and FCC staff members. In turn, bidders also hired game theorists to plot strategies and plan responses to competitors' bids. However, in the end, most companies chose to form alliances and partnerships with possible competitors and work out potential conflicts ahead of time.

The FCC bidding process broke new ground for auctions, and the use of game theory in the design and implementation of the bidding will, perhaps, change the face of auctions forever.

The Auctions
In 1994, four auctions were held. Beginning on July 25, a four-day auction placed 10 nationwide narrowband PCS licenses up for bids. These licenses encompassed a 900-MHz band for two-way paging and messaging services. All licenses were for 50-MHz channels, some of which were paired with other channels. Five 50-MHz channels with five other 50-MHz channels; three 50-MHz channels were paired with 12.5-MHz channels; and two 50-MHz channels were unpaired.

After 46 rounds of bidding, the big winner was Paging Network, Inc., which bought two licenses for $80 million each and one for $37 million. The company intends to begin a service called PageNet that will turn a paging receiver into a portable answering machine. McCaw Cellular also bought two licenses for $80 million each.

In all, the auction of the 10 licenses generated $617 million, much more than the FCC and industry experts had expected.

Running concurrently with the auction for nationwide narrowband PCS licenses, an auction was held July 25 and 26 for 300 interactive video and data service (IVDS) frequency licenses. IVDS is a wireless technology that works with broadcast or cable television programming and links viewers to the program in such as way that they can select camera angles, play video games or shop. IVDS licenses are divided up in the same manner that cellular license areas are, by population. The licenses put up for bid in this auction were for high population metropolitan statistical areas (MSAs). In the end, 178 companies bought the 300 licenses for a total of $215 million — again, more than the experts had predicted.

During the third auction, which began on October 26, 1994, the FCC auctioned 30 regional narrowband PCS licenses. The licenses were divided up into six licenses in each of the five FCC regions. Of the 30 licenses, 10 were for 50-kHz channels that were paired with another 50-kHz channel, and 20 licenses were for 50-kHz channels paired with 12.5-kHz channels. At the completion of the auction on November 8, a total of $490.9 million had been bid for the licenses. PCS Development Corporation came away as the big spender, paying over $151 million for five of the paired 50-kHz channels. The most paid for one of the 50-kHz/12.5-kHz channels was $18.7 million.

The December 5 auction was the main event for 1994. It was the beginning of a series of auctions for 2,074 licenses for wideband frequencies covering 120 MHz. Three blocks (A, B and C) were 30-MHz channels, and three blocks (D, E and F) were 10-MHz channels. When completed, the auctions sold 99 licenses in the 51 parts of the country designated by the FCC as major trading areas (MTAs) and four licenses in each of the FCC's 493 basic trading areas (BTAs). Each of the licenses could be used to provide PCS communications within the designated geographic areas.

Bidding on the initial blocks took three months to complete and lasted 112 rounds. Of the 30 bidders that began the process, only 18 stayed to the final rounds. When the dust cleared, the auction had generated a total of $7.7 billion in revenue. A group of bidders led by Sprint and its three cable television partners (Tele-Communications, Inc., Comcast Corporation and Cox Communications) paid $2.1 billion for licenses in 29 areas. AT&T paid $1.7 billion for licenses in 21 markets, and a consortium of RBOCs paid $1.1 billion for licenses in 11 cities. The license for Los Angeles was the most expensive, costing Pacific Telesis Group $493 million.

Of the 2,074 licenses, 986 were set aside for bidding by DEs. The auction for 493 of the DE licenses was delayed in March 1995 by a district court ruling; however, on May 1, 1995, the court lifted the stay, and the auction for group C (30-MHz licenses for BTAs) was set to begin August 2, 1995.

Additional auctions for wideband PCS licenses will be held in 1995, and the FCC expects to complete the sale of them by the end of the year. Future auctions will include licenses for a 900-MHz band for specialized mobile radio (SMR), cellular telephone frequencies for areas in which there is no cellular service, multichannel multipoint distribution services (MMDS), automatic vehicle monitoring and digital audio radio. In addition, the FCC is considering an auction to sell telephone numbers for a variety of phone services, such as 800-number (toll free) service.

The radio frequency spectrum is a finite range of electromagnetic waves that can be used for communications. Since it is a finite resource, the RF spectrum is subject to the economic factors of supply and demand. As there is an increase in services that require radio frequencies, the value of frequencies will also rise. Additionally, as technological advances enable more types of communications to use radio frequencies and consumers become willing to pay for those services, the commercial value of the frequencies increases.

As the federal agency charged with managing and allocating public radio frequencies, the FCC must act as "public convenience, interest, or necessity requires." Although future auctions can only be mandated by the U.S. Congress, it appears that the auctions' recent success and $9 billion in proceeds has established a new way for the FCC to accomplish its mission.

u contributed by Paul Stranahan

Fuchs, Michael J. (1946 –   )

American businessman who is the Chairman of Home Box Office and the Chairman of Warner Music Group.

Since October 1984, Michael J. Fuchs has been the Chairman and Chief Executive Officer of Home Box Office (HBO) and responsible for the overall management of the nation's oldest and largest pay-TV company. In May 1995, he handed the reins and CEO title for the premium cable service over to Jeffrey Bewkes and assumed the responsibilities of Chairman for Warner Music Group.

HBO is a 24-hour pay-TV service distinguished by the quality and diversity of its commercially uninterrupted programming. HBO was the first in the industry to schedule feature motion pictures on a nightly basis without commercials as a draw for cable subscribers. Launched in November 1972 by Charles "Chuck" J. Dolan with its first film, *Sometimes a Great Notion*, HBO was acquired by Time Warner, Inc. in 1973.

In September 1976, Fuchs joined HBO and was initially responsible for original and sports programming. In a rapid ascent, he was promoted to President and Chief Operating Officer of HBO in March 1984, and later elevated to Chairman and CEO after Frank Biondi's resignation in 1985.

A native New Yorker, Fuchs received a BA degree in political science from Union College in Schenectady, New York, and a JD degree from the New York University Law School. He then worked as an associate specializing in entertainment law with two law firms in New York City. Following an 18-month association with the New York office of the William Morris Agency, he joined HBO.

Under Fuchs' leadership, HBO continues to deliver the broad-appeal programming for which it is known. Each month there are more than 60 motion pictures, as well as exclusive new entertainment specials. These range from music, comedy and drama, to documentary and series programming, sports specials and a broad spectrum of family programming. Since the May 1983 airing of *The Terry Fox Story*, HBO regularly presents viewers with award-winning original movies.

As for Warner Music Group, the move was designed to end a feud between the division's ex-chairman, Robert Morgado, and executives at the company's three major record labels, and to satisfy Fuchs' desire for a greater challenge after nearly 20 years with HBO. With his additional responsibilities at Warner Music Group, Fuchs now occupies a key position of power at Time Warner.

Fuchs serves on a variety of boards for both charitable organizations and business concerns — Turner Broadcasting System, Inc., the National Cable Television Association (NCTA), Marvel Entertainment Group, the Hebrew Home for the Aged at Riverdale, the American Foundation for AIDS Research, the Creative Coalition, the Environmental Media Association, the Alzheimer's Association, the Simon Wiesenthal Center, Bryant Park Restoration Corporation, and American Friends of the Israel Museum. He is also a trustee of the American Film Institute, the Bronx Museum of the Arts, the American Museum of the Moving Image and the Brooklyn Academy of Music.

u contributed by Diana L. Hollenbeck

Editor's Notes:
Time Warner Inc. acquired Turner Broadcasting System Inc. in the fall of 1995. Shortly after the deal was announced, Michael Fuchs resigned as the head of Warner Music and Chairman of HBO.

Gamble, James (1826 – 1905?)

American telegrapher and pioneer in the establishment of telegraph lines in California.

James Gamble was born in 1826 near Baltimore, Maryland. His family then moved to Alton, Illinois, where as a young man he worked in a printing office. Gamble was intrigued with the beginnings of the telegraph. After he learned Morse code, he soon went to work as a telegrapher for the Illinois & Mississippi Telegraph Company. By 1850, he was managing the Chicago office.

Out west, the citizens of the young state of California had awakened to the value of the telegraph as a means of rapid communication. Prior to 1852, the state's population shifted so rapidly from place to place that it would have been useless to set up telegraph poles. No sooner would the line have been completed than the community it had been intending to serve would have moved on to "greener pastures." But the gold fever had begun to cool, business was settling down, and future commercial centers were beginning to establish themselves.

In 1852 Gamble left his Chicago position and headed west to seek his fortune. That same year, the California Telegraph Company was organized by two enterprising promoters from New York, Oliver E. Allen and Clark Burnham. Allen and Burnham had obtained the right to establish a telegraph line between San Francisco and Marysville via San Jose, Stockton, and Sacramento. For their exclusive rights to the route for 15 years, they were obligated to have the line in operation by November 1, 1853, and to pay the state three percent of their net proceeds. The California Telegraph Company met with many misfortunes, and as a result of severe losses from the great fire which swept through San Francisco, was unable to build the line.

New capital was enlisted to save the valuable franchise, and on June 1, 1853, the company was reorganized as the California State Telegraph Company with a capitalization of $300,000 and John Middleton as President; E.R. Carpentier, Secretary; and Joseph C. Palmer, Treasurer. After many delays, work was begun on September 13, 1853, with only six weeks remaining to complete the line before the expiration of the contract. Fortunately, the company's Superintendent, W.B. Ransom, secured the services of Gamble. As the supervisor of construction, Gamble and a band of five men set out to erect 200 miles of telegraph through a rugged and undeveloped country. With a workday that went from sun-up to sun-down, they progressed five or six miles on good days.

When the first regular telegraph office was opened in San Jose, interested spectators gathered, hoping to understand the mysteries of this strange new wonder. Gamble could not resist the impulse to play along. When he received the first message from San Francisco, which he copied and placed in an envelope, the audience thought he was preparing a message for transmission. He then hid the dispatch under the table while he kept his eyes fixed intently on the outdoor wire. With his right hand he began working the telegraph key. The moment the crowd heard the first click on the instrument they all rushed from the veranda out into the street to see the message in the envelope pass along the wire. As they failed to see it, their second supposition was that the wire was hollow and that the envelope with its message was forced through the hollow part to its destination. But people soon understood the real power of the telegraph. They used it so frequently that the California State Telegraph Company was one of the most profitable of its size.

On October 25, 1853, the line to Marysville was completed, six weeks from the day it began, and a valuable franchise was saved. Gamble was named Manager of the company’s office in Sacramento at a wage of $200 per month.

In 1861, the Pacific Telegraph Company placed Gamble in charge of building approximately 800 miles of the first transcontinental telegraph line from the Pacific Ocean to Salt Lake City, Utah, where he would connect with Edward Creighton’s westbound telegraph coming from Fort Kearney, Nebraska. Gamble had to wait for a ship to come around Cape Horn, laden with wire, insulators, and other supplies. Then he, I.M. Hubbard, and 50 others drove 228 oxen, 26 wagons and 18 mules and horses on rough mountain trails over the Sierra Nevada mountains to get the supplies to Carson City, Nevada. Their first pole was set up at Fort Churchill, Nevada, on June 20, 1861. Daily progress for each party was often five to ten miles. However, once 16 miles of line were erected on the Plains in one day in an effort to reach the next water hole. By October 24, 1861, the line was completed and the first transcontinental message was sent from Chief Justice Stephen J. Field of California to President Abraham Lincoln.

In 1864, Gamble ramrodded through the 300-mile expansion of the line from Portland, Oregon, to New Westminster, British Columbia. Gamble also established the Pacific Telegraph Company’s line from San Francisco to Salt Lake City in 1866.

Gamble was married and had one daughter, Mary.

u contributed by Diana L. Hollenbeck

Gates, William Bill Henry, III (1955-)

American corporate executive, currently Chairman and Chief Executive Officer of Microsoft Corporation, the world leader in computer software, which he co-founded with partner Paul Allen. Best known for guiding Microsoft to its premier spot in the industry; for devising MS-DOS, the operating system for virtually all IBM and IBM-compatible personal computers in existence today; and for developing Windows, the graphical user interface (GUI) that has taken the personal computing market by storm. He is also the youngest man ever to become a billionaire and the richest man in the world according to *Forbes* magazine.

Bill Gates was born in Seattle, Washington, in 1955 and received his early education at the private Lakeside School. He and his friends, including Paul Allen, became enthralled with the school's computers and formed the Lakeside Programming Group. Over the next few years, young Gates and his friends were involved in several business ventures utilizing their computer expertise. For example, Traf-O-Data, headed by 14-year-old Gates, sold computerized traffic counting systems to municipalities, making $20,000 a year.

After a brief programming stint at software company TRW that delayed his senior year, Gates finally graduated from Lakeside in 1973. Scoring a perfect 800 on the math portion of the Scholastic Aptitude Test (SAT), he enrolled in Harvard's pre-law program.

In 1975, Gates and Paul Allen (then a programmer at Honeywell) initiated their own project to adapt BASIC — the large-scale computer language — to work in a new microcomputer made by New Mexico-based computer manufacturer MITS. Named after a *Star Trek* television episode, the MITS Altair 8800 was the very first personal computer (PC). Despite having no model of the Altair with which to work, the partners' new BASIC language was immediately successful in the computer anyway.

Elated at their amazing success, 19-year-old Gates immediately dropped out of Harvard and Allen left Honeywell. They confidently moved to Albuquerque, where MITS was located, and founded Microsoft Corporation to produce their new BASIC language program for the computer company. Although it soon went out of business, MITS had already started selling the program to Apple Computer and Commodore, among others. The microcomputer era had begun and Microsoft's new version of BASIC became an industry standard and led the market for a number of years.

The two-year-old Microsoft Corporation began developing software for Tandy's popular Radio Shack computers in 1977. Then Gates and Allen moved the company in 1979 to their home state of Washington, settling near Seattle in Bellevue. The turning point for Microsoft occurred in 1981, when IBM bought Gates's Microsoft Disc Operating System (known as MS-DOS), which he developed at IBM's request for its new PC. Foreseeing the need to be IBM-compatible, 50 other companies also purchased licenses for MS-DOS during its first 16 months of availability. MS-DOS quickly became the major operating system used by the burgeoning PC industry and catapulted Microsoft Corporation to the forefront of its field.

Over the next few years, Bill Gates also developed operating programs for Apple's first

Macintosh and Radio Shack's Model 100, among others. He then switched the company's focus from operating systems to applications software, developing such programs as Microsoft Word for the IBM-PC.

Always engrossed and hard-working, Gates took only six vacation days from 1978 to 1984. His workload became excessive when Paul Allen developed cancer, so he began recruiting talent from other computer companies. With annual sales of $140 million in 1985, Microsoft Corporation had grown to 1,200 employees. So the next year company headquarters were moved once again, this time to Redmond, another Seattle suburb. Also in 1986, Microsoft went public, with Gates retaining 45% ownership of the company. Reaping enormous profits from his many innovations and astute business deals, Bill Gates became a billionaire in 1987 at age 31.

Posting a $1 billion fiscal year ending in mid-1990, Microsoft Corporation continued its competitive approach to business. To compete with rival software giant Lotus 1-2-3, Gates strategically cut the price of Microsoft's Excel spreadsheet program. He also developed the incredibly successful Windows GUI program, which allows an IBM-compatible PC to offer an operating feel similar to an Apple Macintosh at a much lower cost.

In 1991, Microsoft was worth over $10 billion, employed 8,000, and successfully launched its DOS 5.0 with a list price of $100. But the company also found itself embroiled in legal battles. Apple Computer, Inc. had filed a copyright infringement suit (the core of which was dismissed in 1992), and the Federal Trade Commission (FTC) was investigating Microsoft for anticompetitive business practices. At about this time, the long-standing alliance between Microsoft and IBM appeared to be crumbling, with IBM joining Apple Computer to combine and share certain technologies.

Aggressive as ever, Microsoft rolled out its 6.0 version of MS-DOS in 1993 and again began working with IBM on porting Windows NT to the PowerPC. The company also released its 3.0 version of the popular Windows, shipping nearly 10 million units. Microsoft's fiscal 1994 sales were $4.7 billion, and the innovative new Windows 95 operating system was released in August of 1995.

Microsoft CEO Gates is still personally involved in the company's product development and keeps in daily touch with employees who contact him through electronic mail (E-mail). He also spends nearly a third of his time dealing with customers, current and prospective. Married to a marketing manager at Microsoft, Melinda French, he now takes more time off than he used to. But as one of history's most successful businessmen, the spotlight is continually on Bill Gates who turns 40 in 1995.

u contributed by Kay S. Volkema

Global Satellite Networks

In July 1961, U.S. President John F. Kennedy invited all nations to take part in a communication satellite system that would unite the world. The first step toward this goal occurred in August 1964, when 11 nations formed the International Telecommunications Satellite Organization (INTELSAT). The second global satellite network, Intersputnik, began in 1971 as an organization of eight Soviet bloc nations. In 1979, the International Maritime Satellite Organization established the third global satellite network, INMARSAT. This cooperative organization was formed to provide satellite communication services to ships and offshore oil rigs.

INTELSAT
The driving forces behind the formation of INTELSAT were the U.S. space exploration and satellite programs. Taking what it learned with Communications Satellite Corporation (COMSAT), which was formed in 1963 to manage all international communication satellites, the U.S. government enlisted other countries to join it in creating a global communication satellite network.

Although there were benefits for all countries who participated in INTELSAT, the United States benefited in particular, for it had two overriding needs that only a global network could satisfy. First, it needed to involve other countries, both economically and politically, to form a worldwide network because global communication satellite networks are complex and expensive propositions. Countries that are members of INTELSAT own and operate the ground stations within their borders; however, initially the technology came from the United States. Working together, participating countries could have the benefits of global communications and share the costs. Politically, the United States needed to solidify its relationship with various allies as it raced the USSR for dominance in space, and the United States also needed to obtain permission from foreign countries to use the radio frequencies that were controlled by those countries. Here's why: an international communication channel is divided into halves, with one half belonging to the transmitting country and the other half belonging to the receiving country. The transmitting country can send a signal to a satellite; however, without the permission of the receiving country, the signal can not be retransmitted from the satellite to an earth station in that country.

Second, the United States was on the threshold of a huge manned-flight space program that required a seamless global network to transmit voice, data, video and telemetry signals to and from astronauts in orbiting spacecraft and later on the moon. The Apollo Program, begun in 1968, involved extended flights by astronauts and required constant communication links with ground facilities. This could only be accomplished if the United States could build and operate earth stations in many foreign countries. INTELSAT enabled the United States to meet its ambitious goals, so the United States, operating through COMSAT, nurtured the construction of the first global communication satellite network for the benefit of all the participating nations.

By the mid-1990's, INTELSAT had 132 member countries and provided services to dozens of additional countries using over 20 satellites positioned in geosynchronous orbits over the Atlantic, Pacific and Indian oceans. Among its services, INTELSAT provides communication capability to underdeveloped countries. Realizing that communications were essential to economic development and maintaining contact with the "global village," INTELSAT offered services to countries that could not afford to pay their own way. In 1988, the minimum investment share for member countries was $850,000, an amount that constitutes a major portion of some small countries' national budgets. Using INTELSAT capabilities has enabled some member and nonmember countries to create domestic communication satellite networks to provide telephone service. In areas where the construction of a land-based telephone network is too costly, INTELSAT satellites are essential for domestic as well as international communications.

Intersputnik

Intersputnik, begun in 1971 by the Soviet government, was open to any sovereign state; however, it was strongly associated with communist countries. Intersputnik now includes satellites in geosynchronous and Molniya orbit (a non-geosynchronous orbit), since the former USSR included significant areas above the arctic circle that cannot be reached by satellites in a geosynchronous orbit around the equator.

Intersputnik leases transponder capacity to foreign countries and corporations, and its membership includes countries that are non-communist, such as the United States. Intersputnik services include telephony and television, and it was used in 1980 to broadcast the Moscow Olympics. The Goodwill Games broadcast in 1985 was the first major use of Intersputnik by the United States. Turner Broadcasting received live broadcasts of the games and carried the event on the cable superstation WTBS.

INMARSAT

INMARSAT grew out of a need for reliable communications with ships at sea and a concern for the safety of sailors. Just as the Greenwich Observatory in England had used electromagnetic waves to broadcast time signals to ships at sea in the late 1800's to improve navigation, the INMARSAT satellite system offers radio determination services, as well as telephone, telex, data and facsimile transmissions, videotex, weather information and distress signals.

INMARSAT provides communication services to offshore drilling rigs, seismic survey ships, fishing boats, cruise ships and many other ocean-going vessels. Satellite communications enable shipping companies to improve the coordination of ship movements, shipping schedules and freight transfer. Using the global network also puts ships in touch with rescue services, medical professionals and essential weather information, making life on the open seas safer.

INMARSAT, which is structured much like INTELSAT with member countries, initially leased satellite capacity from MARISAT, the United States maritime communication satellites; INTELSAT; and the European Space Administration (ESA). In 1994, INMARSAT had 75 member nations.

In addition to maritime services, INMARSAT is also providing communication services to aircraft. Through INMARSAT, passengers on airplanes are able to make phone calls from on-board telephones.

Future Global Systems

Traditionally, global communication satellite networks have been limited to groups of nations that band together for the benefit of all. The immense financial commitment to design, build, launch and maintain such a network has created INTELSAT, Intersputnik and INMARSAT. For a single company or group of companies to initiate a global network involves negotiations with each country to secure the use of the radio frequencies that each country controls. However, several significant private ventures have surfaced in 1995 that could change the face of global satellite communications.

Motorola plans to build and launch a network of 66 satellites in a non-geosynchronous low-earth orbit (LEO). The project, called Iridium, would enable people with portable telephones to make and receive calls from anywhere on the planet. Since the high-power satellites will be only 300 to 500 miles above the Earth, the signals can be transmitted by small, cellular-sized telephones. Iridium satellites would be linked together, giving them the capability to send a signal from one satellite to another, a feature none of the other global systems includes. With the Iridium system, a call would go directly from a handset to a satellite and not return to Earth until it was received by the intended person.

Teledisc, which is a joint venture between William “Bill” Gates of Microsoft and Craig McCaw, former owner of McCaw Cellular, is proposing to launch 900 global communication satellites into LEO. In the Teledisc system, approximately 840 of the satellites would be active, with the remainder serving as backup. The satellite system would enable voice, data and video to be transmitted.

Other companies are also proposing global networks comprised of fewer satellites. Ellipsat’s Ellipso network would include 24 satellites; TRW’s Odyssey network would have 12; Loral/Qualcom’s Globalstar system and Constellation’s Aries network would each have 48 satellites. All are shooting for an operational date before the year 2000. INMARSAT is also considering a system called INMARSAT-P that would provide global service to mobile telephones.

In January 1995, Iridium, Odyssey and Globalstar received approval from the Federal Communications Commission (FCC) to continue their efforts, and by mid-year Globalstar was testing its first satellites that were in orbit.

Those who see a need for a global communication satellite system to serve mobile phones believe that people who work in many occupations that involve travel to remote areas, including surveyors, construction engineers, geologists and salespeople will use it extensively. In addition, a global system would provide an instant telephone network for undeveloped countries without the slow and costly construction of land lines.

Since the first elementary efforts at satellite communications in the 1950’s, the technology has enabled billions of people to have access to those in neighboring countries or across the oceans. Expanding technology in satellites and hand-held communication devices will continue to shrink the village in which we live.

u contributed by Paul Stranahan

Graphical User Interface (GUI)

A visually oriented computer program--the actual face a computer presents to the user--that simplifies computer operations through on-screen graphics.

The Graphical User Interface (GUI) was widely introduced in 1984 with the Apple Computer. It greatly changed the way consumers use their computers by eliminating text-based, keyboard-driven commands, replacing them with a visually oriented, user-friendly interface between computer and user.

A GUI (pronounced goo-ey) creates screen displays that replace the need for memorized commands when working on a computer. Instead, users access small pictures, or icons, for each program desired. Various input devices, such as keyboards, mice, and trackballs, are used to point to each icon, thereby launching a program for execution or allowing other functions to be selected from on-screen lists, buttons or windows.

The theory behind GUIs was first envisioned in the late 1960's by Doug Engelbart, a researcher at Stanford Research Institute (SRI). Engelbart had conceptualized a model of interactive computing that would assist people in their handling and processing of information. His research led to the establishment of the Augmentation Research Center (ARC) at SRI. With funding assistance from the Department of Defense's Advanced Research Projects Agency, Engelbart developed an interactive system that included a number of tools that were revolutionary at the time. Engelbart's tools--among them on-screen icons, a mouse and a hypertext system--all eventually became part of the Macintosh architecture.

Engelbart's research at ARC was furthered by research conducted in the early 1970's at Xerox Corporation's Palo Alto Research Center (PARC). Efforts there resulted in the first personal computer--the Alto--introduced in 1972 as an interactive computer system complete with many features commonly found on today's computer systems. Although amazingly advanced for its time, Xerox never sold the Alto commercially. However, it too contributed to the future development of the Macintosh system.

The introduction of the personal computer in the early 1980's further drove efforts for making computers easier to work with. Now, as never before, the population at large could enter an arena that until then had been inhabited by researchers and electronics hobbyists--and this new audience expressed little interest in learning how computers actually worked. What users now wanted were programs that provided direct access to the new software application programs that were beginning to flood the market.

New needs created greater demand for software that would further simplify communication between users and computers. These first software interfaces were large, cumbersome programs, requiring a great deal of a computer's processing power in order to run. However, their ease of use greatly outweighed their lack of speed, and they gained instant popularity among new computer users. Serious computer users initially ridiculed the need for GUIs, but refinements to the early programs, as well as the GUI's seemingly intuitive nature, eventually won over even the most severe critics.

Today, GUIs are the predominant choice in operating environments. Although they share a number of characteristics, including such basic GUI components as icons, menus, status bars, windows and on-screen boxes, the actual representation of these objects vary depending on the specific GUI being used. Although they vary in appearance, the applications designed to run within specific GUIs tend to share attributes. Most programs designed to run on a Macintosh, for example, behave and look alike. Programs designed to run under Microsoft Windows also behave similarly. GUIs can also allow more than one program to run at the same time, allowing computer users to check information in one program while conducting work in another.

GUIs now come standard in all Macintosh applications; many other computers are sold with interfaces already installed. For other systems to operate under a GUI, the computer itself must be equipped with a program that contains a GUI. Examples of such programs include Microsoft Windows, largely used on DOS-based computers; and Motif, which runs on systems using the Unix operating system.

Newer GUIs enable applications designed for one operating system to easily move to another; this flexibility allows Windows and Mac applications to operate on either environment or platform. Some new GUIs feature interfaces that emulate the "real world," putting users inside highly realistic, even 3-dimensional settings. In coming years, GUIs may resemble actual faces, and may include speech-recognition software that will further facilitate the user-friendly interface that was the dream of the earliest GUI developers.

u contributed by Sonia Weiss

Gray, Elisha (1835 – 1901)

American inventor of more than 60 patented devices, including a multiplex telegraph, but chiefly known for losing the patent rights to the telephone to Alexander Graham Bell.

Born in Barnesville, Ohio in 1835, Gray was educated at Oberlin College. In his mid-thirties, he and E. M. Barton co-founded a manufacturing concern called Gray and Barton, which eventually became the Western Electric Company.

During the 1860’s and 1870’s, the Universal Private Line Printer developed by Gray was used by the majority of privately leased telegraph lines in the U.S. In 1875, he received a patent for his harmonic telegraph, which simultaneously sent messages in a variety of musical tones over telegraph lines.

Then, just hours after Alexander Graham Bell registered for his patent on the telephone in March 1876, Gray also filed a claim for its invention. This halted Bell’s patent request and resulted in a long, bitter legal battle between the two inventors. The U.S. Supreme Court eventually sustained Bell’s right to the patent — one of the most lucrative ever granted.

From 1880 to 1901, Gray was a professor of dynamic electricity at his alma mater, Oberlin College. During this time, he patented a facsimile telegraph system, and his harmonic telegraph system was utilized by Postal Telegraph, the major competitor of industry giant Western Union.

Gray died in Newtonville, Massachusetts, in 1901 at the age of 66. Although not officially credited with inventing the telephone, Elisha Gray made many other contributions to the advancement of early telecommunications.

u contributed by Kay S. Volkema

Green, Richard Roy (1937 –)

American electronics engineer, physicist, researcher, scientist, and President and Chief Executive Officer of Cable Television Laboratories, Inc. (CableLabs) in Boulder, Colorado. Dr. Green is known for his engineering leadership at the Public Broadcasting Service (PBS), his long-term research in high definition television (HDTV), and for his views that the key to converging technologies will be interoperability.

Richard Green was born on June 10, 1937, in Colorado Springs, Colorado, and grew up there. He attended Colorado College, also in Colorado Springs, where he received a BS in 1959. In addition, he earned an MS in Physics from the State University of New York in Albany in 1964. In 1968, he received a Ph.D. from the University of Washington. Dr. Green and his wife, Cynthia, have three grown children.

He began his career in 1964 at Boeing Scientific Research Laboratories, where he served as a senior staff scientist until 1972. In addition, from 1968 to 1972, he was Assistant Professor at the University of Washington. From 1972 to 1977, he did basic research in laser technology for the Hughes Aircraft Company in Los Angeles. Moving to the American Broadcasting Company (ABC), he managed the Video Tape Post Production Department from 1977 until 1980.

In 1980, Green was named Director of the Columbia Broadcasting System's (CBS) Advanced Television Technology Laboratory in Stamford, Connecticut. In addition to his work at CBS in digital television and high definition television, he chaired a digital television group of the International Radio Consultative Committee (CCIR). This committee is now known as the International Telecommunications Union – Radio, or ITU-R. The committee eventually developed Recommendation 601, a worldwide television standard for digital signals.

During his tenure at CBS, Green helped produce the first series of experimental programs mastered in high definition television (HDTV) in the United States. This collaborative effort between CBS, Nippon Hoso Kyokai (NHK), Japan's public broadcasting corporation, and Sony brought about the first experimental programs using HDTV. These included an NFL football game between the Los Angeles Rams and the Washington Redskins in 1981, the Rose Bowl Parade, an episode of "The Fall Guy" television program, and a series of cinema segments produced by Francis Copola in HDTV.

In 1982, Green also participated in the production of a series of international HDTV programs. This effort was in cooperation with European broadcasters including SFP France, the British Broadcasting Corporation (BBC), Swiss Television and Soviet Radio and Television.

In 1983, Green helped organize and establish the Advanced Television Systems Committee (ATSC), the group created to define the new television standards for the United States.

Green was named Senior Vice President of Broadcast Operations and Engineering at the

Public Broadcasting Service (PBS) in l984 and served in that capacity until 1988. While at PBS, his contributions included construction of its national network origination and transmission facilities. He was named President and Chief Executive Officer of Cable Television Laboratories, Inc. (CableLabs) in August 1988.

Since that time, Green has led CableLabs in its quest to chart the technical course of the cable television industry. Established in 1988, CableLabs is a research and development organization composed of leading American and Canadian cable television companies. Through its member companies, it currently represents more than 85% of the cable subscribers in the United States, 70% of the subscribers in Canada, and 10% of the subscribers in Mexico.

Active in a variety of areas, Green is a member of Phi Beta Kappa, the American Association for the Advancement of Science and the Society of Motion Picture and Television Engineers (SMPTE). He has written more than 55 technical papers. In addition, Green was named “Man of the Year” by *CED* magazine in 1993.

Dr. Green’s technical achievements and his quest to find a way to bring affordable high-definition television to the American cable subscriber distinguish him as a leader in the television industry.

u contributed by Valerie Switzer

Greene, Judge Harold Herman (1923–   )

German-born American federal court judge who ultimately presided over the largest antitrust lawsuit in history, U.S. vs. AT&T, and still retains jurisdiction over it and its ongoing ramifications.

Greene was born Heinz Grunhaus in Frankfurt, Germany in 1923. At the age of 16, he and his Jewish parents fled their turbulent homeland. Staying in various European countries over the next few years, they finally immigrated to the U.S. in 1943 in mid–World War II.

Young Grunhaus became a naturalized American citizen in 1944 and changed his name to Harold Greene. He also enlisted in the U.S. Army and was stationed in Allied-occupied Germany. Spending most of his duty in military intelligence there, staff sergeant Greene was honorably discharged in 1946. Two years later, he married Evelyn Schroer, originally from an area near the German/French border, and together they had two children.

Working during the day as a translator for the U.S. Department of Justice, Greene attended night classes at George Washington University and obtained a bachelor's degree in 1949. He received his doctorate of law three years later, graduating first in his class. Shortly afterward, Greene began practicing law. He clerked for the U.S. Court of Appeals in Washington, D.C. for a year, then worked as an Assistant U.S. Attorney for the District of Columbia until 1957.

Working in the Justice Department, Greene was befriended later by Attorney General Robert F. Kennedy and they collaborated on groundbreaking civil rights legislation in the 1960's. President Lyndon B. Johnson appointed him Associate Judge of the District of Columbia Court of Grand Sessions, and Chief Judge the next year. Congress then successively confirmed Greene to two 5-year terms beginning in 1971 as Chief Judge of the expanded Superior Court.

In 1974, Attorney General William Saxbe filed the largest antitrust suit in history, U.S. vs. AT&T. With Judge Joseph Windys presiding, the lawsuit claimed that AT&T and its affiliates had violated the Sherman Anti-Trust Act by conspiring to monopolize telecommunications services and equipment. Four years later, President Jimmy Carter rewarded Greene's distinguished record by giving him a lifetime federal judgeship in the District of Columbia Federal Court, a most prestigious assignment. Within days, Judge Greene received exclusive jurisdiction over the controversial AT&T case upon Judge Windys's retirement, and Greene decided to try it without a jury.

The trial began in 1981, six years after Saxbe filed suit. After hearing months of testimony from hundreds of witnesses, reviewing thousands of documents, and being criticized and praised by various politicians and corporations, Judge Greene finally issued the consent decree in 1982. After some modification later that year, it became known as the "Modified Final Judgment" (MFJ). The decree mandated that AT&T

divest its 22 Bell operating companies, with a combined estimated worth of $80 billion. Divestiture officially took place on January 1, 1984 and is commonly known as the breakup of “Ma Bell”. AT&T was allowed, however, to keep Bell Laboratories and Western Electric, and expand into previously prohibited (but lucrative) fields such as data processing, computer communications, and equipment sales.

After divestiture, Judge Harold Greene retained his jurisdiction over enforcement of this detailed and far-reaching decree. More than a decade later, he still spends about one-third of his time making decisions affecting AT&T and the regional Bell holding companies. A truly monumental case, U.S. vs. AT&T has virtually monopolized Harold Greene’s federal judicial career.

u contributed by Kay S. Volkema

Editor's Notes:
Judge Harold Greene has been asked by the Justice Department to eliminate the Modified Final Judgment of 1982. The Telecommunications Act of 1996 provides new guidelines for telecommunications regulation, and the Department of Justice believes that Judge Greene's involvement with the issue is no longer necessary.

Groupware

Software that facilitates access to business and personal productivity applications by a group or network of users. Groupware allows people to work on projects together or individually, at the same time and place or at different times and in varied locations. Electronic mail and bulletin board systems are two common examples of groupware applications.

Groupware, or group software, describes a family of software products that enables people to work together with few geographic or logistical boundaries. By eliminating the isolation caused by using individual personal computers, and combining the resources of a number of people who might not otherwise communicate, groupware has the potential for generating new ideas and increasing productivity, as well as for speeding communication.

Groupware allows work to be carried out in various settings, or environments, that support team interaction in one office or many. The size of the group, the physical proximity of its members, and how often and when interaction is needed between members are the main factors that shape groupware environments. These environments can range from programs that support the needs of large groups at multiple sites meeting at the same time to managing face-to-face interactions in smaller settings over a longer period of time.

Common groupware application packages combine electronic mail, memos and reports; individual and group scheduling; and directories of group projects. Other groupware applications include document editing packages, which allow several people to work on the same document either at the same time or individually, and forms-centered packages, which coordinate routine transactions through a standard cycle.

u contributed by Sonia Weiss

Grove, Andrew S. (1936 –   )

Hungarian-born American President and Chief Executive Officer of Intel Corporation headquartered in Santa Clara, California. A researcher and fierce competitor in the microprocessor industry, Grove has led the organization to a commanding position as the largest supplier of computer chips in the world, while realizing enviable gross profit margins on many products.

Andras Grof was born in Budapest, Hungary, in 1936, and during his youth had dreams of becoming an opera singer. He also had aspirations of becoming a journalist. However, because of political implications in the arrest of a relative in Hungary during World War II, his essays were not published. It was then that he decided on a career in science.

In 1956, one year after the Soviet invasion of Hungary, Grof emigrated to New York. He worked as a waiter while earning a BS in chemical engineering from City College of New York. He received his undergraduate degree in 1960. In 1963, he received a Ph.D. in chemical engineering from the University of California at Berkeley.

He became an American citizen and changed his name to Andrew Grove. In 1963, he joined Fairchild Semiconductor as Chief of Research and Development. It was there that he met Robert Noyce and Gordon Moore, two of the original founders of Fairchild. Noyce was co-inventor of the integrated circuit.

In 1968, Noyce and Moore left Fairchild to start Intel Corporation, a name they selected from the contraction of two words, *int*egrated *el*ectronics. Grove joined them in creating the company. Their one-page business plan stated that the organization was “going into large-scale integrated circuits.” The company issued a public stock offering in 1971.

In 1979, Grove became President of Intel. A highly competitive leader, Grove instituted a plan to lure at least 2,000 new customers from Intel’s rival, Motorola. The plan worked. One of its new customers was International Business Machines (IBM). A pivotal point in Intel’s success was IBM’s decision to buy Intel’s 8088 chip as the microprocessor for its first personal computer (PC). Today, IBM remains one of Intel’s largest customers.

In 1985, because of the decision by Japanese competitors to drastically undercut the price of memory chips, Grove decided to discontinue Intel’s production of DRAM (dynamic random-access memory) chips rather than enter into price-cutting agreements. After severing that division of Intel’s business, Grove found he had to lay off thousands of employees. This was nearly 30% of Intel’s work force.

In 1987, Grove was named Chief Executive Officer of Intel. Through the years, he has led the company to an enviable market position as the largest producer of semiconductors in the country. Intel has also achieved a remarkable reputation for earning high profit margins — as high as 56% gross profit on some products.

In 1993, Intel introduced its now famous Pentium chip. Grove came under fire once again for the company’s slow response to criticism that the chip had a flaw that caused miscalculations in doing highly complex scientific computations. After first seeming to ignore the problem, Intel chose to replace the Pentium chip as needed. Under Grove, the company has also developed and begun marketing ProShare, a videoconferencing system.

Grove has written over 40 technical papers and holds several patents on semiconductor devices and technology. He has taught a graduate course in semiconductor device physics at the University of California at Berkeley. In addition, he is currently a lecturer at the Stanford Graduate School of Business. He has written three books. *Physics and Technology of Semiconductor Devices* was published in 1967 and has been used as a textbook at many major universities. A second book, *High Output Management,* has gone through two printings, in 1983 and 1985. It has been translated into eleven different languages. His latest book, *One-on-One With Andy Grove* was published in 1987 and reprinted in 1989. In addition, he has written articles for *Fortune, The Wall Street Journal* and *The New York Times,* and has written a column on management for *Working Woman* magazine.

Dr. Grove has received numerous awards. He has been elected a Fellow of the Institute of Electrical and Electronic Engineers (IEEE) and was named a member of the National Academy of Engineering. In 1990, he received the George Washington Award from the American Hungarian Foundation. In September 1993, he was awarded the American Electronics Association 1993 Medal of Achievement. He and colleague Gordon E. Moore were elected Fellows of the Academy of Arts and Sciences in March 1994. Grove and his wife live in the San Francisco Bay Area of California. They have two grown daughters.

u contributed by Valerie Switzer

Hartenstein, Eddy W. (1951 –)

Direct broadcast satellite (DBS) service industry executive, telephony and data distribution services executive, NASA mission planner, and aerospace engineer. Eddy Hartenstein is presently known for orchestrating DIRECTV's successful 1995 rollout of DBS programming based on digital technology.

During his childhood, Hartenstein lived in Los Angeles, California, where his parents owned a Swiss restaurant. He received a BS in aerospace engineering in 1971 and a BS in mathematics in 1972 from California State Polytechnic University in Pomona, California.

After joining Hughes Aircraft Company in 1972, Hartenstein held a succession of engineering, operations, and program management positions at Hughes' Space and Communications Company and NASA's Jet Propulsion Laboratory. Among his positions was Mission Planner for the Viking and Voyager spacecraft programs. He attended the California Institute of Technology as a Hughes Aircraft Company Masters Fellow and received an MS degree in applied mechanics in 1974.

In 1981, Hartenstein transferred to Hughes Communications. As a Vice President, he directed the marketing and development of the Galaxy satellite system to serve the broadcast television and cable programming industries. From 1984 to 1987, he was President of Equatorial Communications Services Company, which provided nationwide telephony and data distribution services for Fortune 100 companies.

Hartenstein created and headed the Ku-Band Services business unit of Hughes Communications, Inc. from 1987 to 1990. During that period, he spearheaded the acquisition of IBM Corporation's Satellite Transponder Leasing Corporation and the Satellite Business Systems (SBS) fleet of Ku-band satellites.

Since 1990, Hartenstein has been developing his brainchild, DIRECTV, into a viable digital DBS system that transmits programs directly to households via satellite. As President of DIRECTV, a unit of GM Hughes Electronics, he has masterfully formed alliances with consumer electronics manufacturers and retailers, video programmers, and customer service providers to ensure successful market entry and penetration.

During this endeavor, two key events have exemplified Hartenstein's keen marketing acumen. First, he delayed DIRECTV's rollout until the company had tackled the quality problems revealed during test broadcasts. Second, identifying sports fans as DIRECTV's primary customer base, he landed an agreement with the NFL to sell $139 "Sunday football season tickets" to subscribers. DIRECTV has been a consumer hit since it began broadcasting in June 1994. After less than a year of operation, the company boasted nearly 500,000 subscribers.

Hartenstein expects DIRECTV to reach its break-even point of 3 million subscribers by early 1997 or sooner. If his predictions hold true, DIRECTV will have 10 million subscribers by the year 2000.

u contributed by Nancy Muenker

Headend

In cable television, the headend receives signals from antennas, processes them and sends them through the distribution system to customers.

Before a cable television signal reaches its final destination — a viewer's television set — it must travel through an array of interconnected systems designed to move signals from their original source to cable television subscribers. The headend is the central component of this array. It collects and processes television signals from antennas, satellites and other sources. The headend coordinates all of the signals from these different sources before passing them to the distribution system, which brings the signal to cable customers.

Originally, headends were quite simple. Cable television was first used to simply bring broadcast television signals into areas that could not get good reception with standard antennas. So headends often consisted of a few pieces of automated equipment in a small shed. But as cable television emerged as a multi-billion dollar industry that offered premium movie channels, superstations, special-interest channels, and original public-access programming, headends grew in size and complexity.

Despite this growth, much of the function of the headend has remained consistent. Signal processors located in the headend take incoming over-the-air signals and adjust their amplitude to make sure that all are equally strong, since signals coming from distant sources may be weaker than sources that are closer to the antenna. The signal processor also filters out interfering signals and often reassigns the frequency of the signal to one that is appropriate for the cable system.

Another important piece of headend equipment is a satellite receiver, which is used to process signals that are transmitted via satellite. Other types of signal processors exist to process audio. For instance, some cable systems offer stereo sound with particular channels. Special equipment is needed to process these audio signals.

Commercial insertion equipment allows local commercials to be placed within nationally distributed programming. By using inaudible digital tones, a satellite that is broadcasting a program alerts a computer in the headend that there will soon be a gap in the broadcast to allow for a local commercial spot to be inserted. The computer then switches on a VCR that contains a tape cued to the appropriate commercial and broadcasts the commercial. After the commercial is inserted, the computer switches back to the satellite broadcast.

Headends often house more than simply the signal receiving and processing equipment. The headend building may also contain equipment and facilities that enable it to generate original cable programming. For instance, cable systems frequently offer automated channels that only displayed written text. Using character generators (computers designed to accept information typed into a keyboard and to design graphic layouts), cable stations can offer a greater variety of channels to subscribers. These text-based information channels are often used as community bulletin boards to announce upcoming civic events or to provide weather information.

Sometimes production studios are located at the headend. Many cable systems offer one or more channels — called public access channels — reserved for the community to use. By reserving studio time, and perhaps paying a nominal fee, virtually anyone can use the studio to broadcast original programming. Sometimes cable companies produce their own programs, called local origination programming, such as public affairs or community-specific programs. Production studios, however, usually are not located at the headend. Rather, production studios send their signals to the headend for processing via microwave or cable links.

After processing signals that come from off-air antennas, satellites and local programming equipment and facilities, the headend uses a piece of equipment called a combiner to put all the signals on a single cable and send them to customers via the distribution system.

The headend, however, can only serve a five-mile radius. In order to expand its range, hub sites are connected to the headend with microwave signals or trunk cable. Hub sites only need receivers to pick up the signals coming from the headend to redistribute them. They do not need their own signal processing equipment, satellite receivers or production studios. Like the headend, hub sites serve a five mile radius.

Scrambling Signals

An important headend responsibility is scrambling certain signals before they are sent to customers. Scrambling means encoding the signal in such a way that only those who pay for the signal can receive it. A converter or set-top box connected to the cable customer's television set descrambles the signal.

In addressable cable systems, a computer is used to route signals to specific subscribers and to keep track of what channels subscribers are authorized to receive. Pay-per-view channels are often routed through addressable systems. Cable customers order pay-per-view programming by calling the cable system computer, and using their touch-tone telephones (or sometimes the converter box) to tell the computer what programming to send them. Viewers are able to view the movie or event within minutes.

Though computers, such as these used in an addressable system, have greatly improved the headend's usefulness and ability, its basic function of processing signals remains as it did in the early days of cable television.

u contributed by Christopher LaMorte

Headend In The Sky (HITS)

A service of Tele-Communications, Inc. (TCI) that will deliver digitally-compressed programming to U.S. cable television companies.

Headend In The Sky (HITS) is a service under development by the National Digital Television Center, a division of Denver-based Tele-Communications, Inc. (the nation's largest multiple system cable operator). HITS, expected to be operational by early 1996, will deliver digitally-compressed programming to cable systems across the United States. Cable companies linked to HITS will be able to affordably provide the advantages of digitally-compressed programming to their customers.

When fully implemented, HITS will provide over 100 digitally-compressed channels that will be satellite-delivered to cable system headends. The technology used by HITS will then allow the signals to be transmitted in compressed format into customers' homes. Customers' converters or set-top boxes, produced by leading manufacturers including General Instrument and Hewlett-Packard, will receive the channels and are expected to also offer an array of special features.

Digital compression offers a number of advantages over traditional analog reception. These include increased capacity, improved quality and greater flexibility for multiple vendor access. Through HITS, cable companies will be able to provide digitally-compressed programming without individually investing in the costly facilities necessary to implement this advanced technology.

TCI's National Digital Television Center (NDTC), opened in 1994, is the first full service cable television facility dedicated to digital compression technology.

u contributed by Susan P. Sanders

Editor's Notes:
A number of major companies are working together to develop Intercast technology, an interactive data delivery medium conceived by Intel. The Intercast Industry Group's goal is to create a service which combines television technology with the World Wide Web, allowing end-users to jump between television shows and web pages with the click of a button on a remote control. Companies involved in the effort include Intel Corporation, Continental Cablevision Inc. (under the ownership of US West), Tele-Communications, Inc., Time Warner Cable Programming, General Instrument Corporation, TCI's Headend-in-the-Sky, NBC, Turner Broadcasting, Viacom International, WGBH Educational Foundation, QVC, America Online, Asymetrix, En Technology, Netscape Communications Corporation, Gateway 2000, and Packard Bell.

Heilmeier, George Harry (1936 –)

American electronics engineer and defense researcher, currently President and Chief Executive Officer, Bell Communications Research, Inc. (Bellcore). A renowned researcher, Dr. Heilmeier has worked in both the government defense and civil engineering arenas. He holds 15 patents and has written more than 60 technical papers.

A native of Philadelphia, Dr. Heilmeier was born May 22, 1936, and grew up in Pennsylvania. In 1958, he earned a BS in Electrical Engineering with distinguished honors from the University of Pennsylvania. He received MA, MSE. and Ph.D. degrees in solid-state electronics from Princeton University. On June 21, 1961, he married Janet S. Faunce. Dr. and Mrs. Heilmeier have one daughter, Elizabeth.

Heilmeier joined RCA Laboratories in 1958, and was named Head of Solid State Device Research in 1966. His work with electro-optic effects in liquid crystals led to the first liquid-crystal displays for calculators, watches and instrumentation. It was because of this work that he received, in 1976, the prestigious David Sarnoff Award from the Institute of Electrical and Electronic Engineers (IEEE). In 1968, he was honored as the Outstanding Young Electrical Engineer in the U.S., receiving the Eta Kappa Nu Award. In 1969, he was named Head of Device Concepts Research at RCA.

In l970, he was chosen by the President as a White House Fellow. As a Special Assistant to the Secretary of Defense, he worked on long-range research and development planning, technical assessment and new technical initiatives. During his year-long tenure, he traveled extensively to Latin America and Eastern Europe.

In 1971, he was appointed Assistant Director of Defense Research and Engineering (Electronic and Physical Sciences). In this position, he was responsible for all Department of Defense research and exploratory development in the areas of electronics, computers and physical sciences.

In 1972, he was named a Fellow of the Institute of Electrical and Electronic Engineers (IEEE). In 1974, he received the 26th Arthur Flemming Award as the Outstanding Young Man in Government. The following year, he received a Special Recognition Award from the Society of Information Display.

In 1975, he was named Acting Director of the Defense Advanced Research Projects Agency (DARPA). Two months later, he was confirmed as Director of DARPA. Under his direction, the organization began work on such diverse defense projects as space-based high-energy lasers and reconnaissance systems, stealth aircraft and special applications of artificial intelligence. Also during his tenure there, he was honored on two different occasions with the Department of Defense’s Distinguished Civilian Service Medal, an award that is rarely given twice.

In 1977, Dr. Heilmeier joined Texas Instruments (TI) as Vice President for Research and Development. In 1983, he was appointed Senior Vice President and Chief Technical Officer at TI. In his position, he was responsible for all research, development and engineering activities, as well as corporate development and strategic planning.

After helping guide Texas Instruments for more than 14 years, on March 1, 1991, he was elected President and Chief Executive Officer of Bellcore by its Board of Directors. Bellcore is a communications software and professional services company that was established in 1984 following the divestiture of American Telephone and Telegraph (AT&T). It provides technical support software systems and training to the seven regional Bell operating companies (RBOCs).

In 1993, Heilmeier was awarded the Industrial Research Institute's Medal for outstanding accomplishment in leadership and management of industrial research that contributes to the development of industry and to the benefit of society. In his acceptance speech at the IRI annual meeting in May 1993, he noted that he is an aberration in today's corporate world, for he is a technically trained researcher serving as president and CEO of a billion-dollar corporation. He emphasized his belief that CEOs of major corporations "must understand the technology driving business today as well as the technology that will change business tomorrow." He further stated that "the CEO of today is the 'designer' of the business, and not the 'operator' of the business." Indeed, Heilmeier contends that as advanced technology plays an increasingly greater role in our global economy, successful companies will seek technically trained and competent individuals to serve as presidents and CEOs.

Also in 1993, Heilmeier was named the first Technology Leader of the Year by *Industry Week* magazine, citing his contribution to the development of the national information infrastructure.

Greatly in demand, Dr. Heilmeier sits on more than 15 different boards and advisory committees for major electronics corporations, government committees and universities that specialize in engineering research. He is a member of the Princeton University School of Engineering and Applied Science Leadership Council.

u contributed by Valerie Switzer

Hertz, Heinrich Rudolph (1857 – 1894)

German physicist primarily known for the discovery of electromagnetic radiation. The first to broadcast and receive what are now known as radio waves, he paved the way for the development of wireless telegraphy.

Hertz was born in Hamburg, Germany in 1857. He received a doctorate degree from the University of Berlin in 1880, and began lecturing and teaching in the field of physics. At the time, there was much scientific interest in the theoretical existence of electromagnetic waves, first advanced by Scottish scientist James Clerk Maxwell in 1873.

While Hertz was a professor at Karlsruhe Polytechnic from 1885 to 1889, he conducted experiments testing Maxwell’s electromagnetic theory of light, eventually confirming and expanding it. In his laboratory on the Rhine River, Hertz was able to actually produce electromagnetic waves and measure their wavelength and velocity. And after analyzing their properties, he proved that both light and heat are electromagnetic radiations.

In 1889, he received a professorship at the University of Bonn and continued his research.

Another important Hertz discovery was the photoelectric effect. The hertz — the unit of frequency that is measured in cycles per second and is commonly abbreviated Hz — is named for him. Heinrich Hertz died in Bonn in 1894 at the age of 37, leaving behind a wife and two daughters.

u contributed by Kay S. Volkema

High-Definition Television (HDTV)

A new form of television that presents a picture that is wider than conventional television screens and has twice as many lines of scanning for increased clarity and detail. In the United States, HDTV uses digital technology to process the original signal, transmit the signal, and reproduce the signal at the television set. In addition, the digital audio signal, like that used in the production of compact discs (CDs), results in high-quality audio. The technology used to create HDTV produces a picture that rivals the quality found in a movie theater or on a 35-mm slide.

How It Works

Today, a conventional television screen is made up of 525 or 625 scan lines. HDTV technology has increased the number of scan lines to over 1,000 for increased luminance (the brightness of the picture). The chrominance (color values) of the image are transmitted separately. Because of HDTV's increased definition and separate color transmission, an HDTV signal must carry much more information than existing television channels.

An HDTV image is approximately 25 percent wider than the conventional television image. In current televisions, the standard aspect ratio (relationship of the image's width to its height) is 4:3. HDTV has an aspect ratio of 16:9, which puts it more in line with the ratio used for motion pictures. Television stations occasionally run motion pictures in a format called letterbox, which leaves a black band at the top and bottom of the screen. This is to accommodate the aspect ratio difference between the two. Otherwise, showing a motion picture on a standard television screen requires cropping the picture's width to fit the television screen.

History

Television in the United States operates under standards for TV broadcast and reception in North America that were set in the 1940's by the National Television System Committee (NTSC). Although these standards were based on compromises necessitated by the crude state of the electronics technology at the time, they have never been substantially changed. Color standards, set in the 1950's, were made to fit into the black and white channel that was part of the NTSC standards. By the 1980's, many manufacturers began pushing for new standards to take advantage of the advancements in electronic technology that had occurred in the 40 years since the standards originated.

These new standards were the basis for HDTV. Manufacturers and broadcasters agreed on the general shape of the end product (more scan lines, better resolution, motion picture aspect ratio), but there was no agreement at all on how to achieve it. For example, should the new TV signal be compatible with the old one? A compatible signal would probably result in lower quality, but a non-compatible signal would make billions of dollars' worth of installed TV broadcasting and receiving equipment obsolete. Another question centered around the controversy of whether HDTV signals should be broadcast over the air or be designed for cable or direct satellite broadcast. Cable TV operators pushed for cable delivery technology, TV station owners wanted a continuation of broadcast, and entrepreneurs attempting to break into the TV broadcast market favored satellite.

HDTV Overseas
The problem was not limited to the United States. Over the years, American and European standards for television had varied in some areas, and both had lost most of their television manufacturing to the Japanese. The advent of HDTV was viewed as a way for the American and European manufacturers to get back into the production of television sets, but everyone was afraid to make a move until a standard could be decided upon.

The Japanese were the first to propose a new HDTV standard, which they called MUSE (for *mu*ltiple-sub-Nyquist-*s*ampling-*e*ncoding). The Japanese assumed that most HDTV broadcasts would be transmitted by cable or satellite because of the increased bandwidth that would be required. (Bandwidth represents the information-carrying capacity of a communication channel.) Therefore, they designed their system using a 12-MHz channel instead of the standard 6-MHz used for conventional (NTSC) television. Their answer to the question of compatibility was “no.”

MUSE was turned down by the Europeans, who came up with their own standard. Between 1986 and 1990, a group called Eureka, made up of some 30 firms and laboratories, spent $1 billion to create a new HDTV standard called MAC (for Multiplexed Analog Components). Eureka also created an intermediate standard called PAL-plus that would be compatible with PAL (Phase Alternation Line), the existing European standard for color TVs. By 1992, though, the Europeans began to think that they had made a mistake. Both the Japanese MUSE and the European MAC standards were based on the same analog technologies currently used for NTSC television signals, but the Europeans began to believe that digital technology might be the true answer.

Analog vs. Digital
American firms were slow to get into HDTV, which actually turned out to be an advantage. In 1990, when the Americans were trying to decide on an HDTV standard, all of the proposals being submitted to the Federal Communications Commission (FCC) were based on analog technology. Then at the last minute, General Instrument submitted a digital system called Digicipher.

To understand the impact of this, one must also understand the difference between analog and digital transmissions. Analog transmissions are created by modulating the radio frequency that is used to carry the signal to a receiver, resulting in an electrical waveform that resembles (is analogous to) the original video or sound wave. Digital transmissions, on the other hand, are created by transmitting a binary code that represents specific elements of sound, data or video. Although many felt digital technology offered certain advantages, it was not under consideration since it couldn’t be sent over the existing 6-MHz television channels, a requirement set by the FCC. But General Instrument had finally come up with a way to compress the digital data so that it could be sent over the existing channels; the company called it Digicipher. In fact, General Instrument’s compression system would allow more than one HDTV transmission to be sent simultaneously over a single 6 MHz channel. As a result, standard development was postponed as several companies jumped to develop competing digital systems.

For television broadcasting, the major advantage of digital transmission was the complete elimination of interference. By converting every signal into a binary (one or zero) system, the signal could be transmitted and reproduced practically error-free. It would also allow for making nearly perfect copies. When analog tapes are copied, each copy substantially deteriorates from the original. With digital recordings, however, the 500th generation of copies is indistinguishable from the first. In addition, digital HDTV could provide six channels of CD-quality sound, which would allow for full surround-sound as well as stereo transmission in multiple languages.

A digital HDTV set is really part TV and part computer. It contains a microprocessor that manages the flow of digital data to the various parts of the TV, whether it's the decompression chip that expands the compressed data back to its original form or the digital-to-analog converter that converts the audio data to six channels of high-quality sound. The microprocessor also sends the expanded picture data to a video display circuit, where it is compressed to a displayable image. Due to the heavy demands placed on it for processing data, an HDTV set needs intelligence similar to a high-quality personal computer.

U.S. Standards for HDTV

In the United States, formulation of standards for digital HDTV consumed the early 1990's as the regulatory and technological possibilities developed. The FCC insisted that the new signal fit into the existing 6-MHz channels, and in 1992 the FCC tentatively gave each broadcaster an additional channel exclusively for HDTV broadcasts. This would allow the broadcasters to simulcast both low- and high-definition TV. The FCC figured that after 15 years everyone would have bought a new high-definition television set and the old, NTSC-standard TV signals could be phased out. The old channels would then be returned to the FCC.

Also in 1992, the Advanced Television Test Center, an industry-sponsored group under contract to the FCC, began considering four different digital HDTV systems, with the intent of developing a U.S. standard. Eventually, the companies and groups that developed the first digital systems came together and created a consortium called the HDTV Grand Alliance to aid in this effort. The Grand Alliance included AT&T, General Instrument (a major vendor of cable TV equipment), Zenith, the Massachusetts Institute of Technology, Thomson Consumer Electronics (from France), Philips Consumer Electronics (from Holland), and the David Sarnoff Research Center. No Japanese firms were initially involved, since they insisted on staying with their analog version of HDTV. January 31, 1995, was the deadline given for an acceptable HDTV system to be proposed.

Meanwhile, other problems were brewing. Over-the-air broadcasters disagreed with the FCC's declaration that the additional channel they were given be used only for HDTV transmissions. Broadcasters wanted the freedom to also use this channel for data transmission or multiple television signals, much as the cable television companies were doing. Many broadcasters feared that HDTV, because of its initial high price tag, would not have sufficient appeal to the general public and that it would be years before they used the full potential of the new channel just for HDTV. Unfortunately, the issue became part of the restructuring of the telecommunications law in Congress and has been caught up in the political wrangling around all of the telecommunication issues.

HDTV's Future

Although the Grand Alliance missed its original deadline of January 31, 1995, the group was able to turn over a final plan in March. The Advanced Television Test Center began testing the plan in the spring of 1995 and anticipated submitting the system to the FCC by the fall of that year. The FCC hopes to have the system standardized by the spring of 1996. NBC has already announced that it expects to start broadcasting HDTV signals as early as the fall of 1997.

The issue of how broadcasters can use their additional channel has not been resolved, and the FCC is considering reopening its 1992 decision. Because the FCC has suggested that broadcasters might lose their second channels completely or that these free channels might begin to cost money, the broadcasters have backed off a little. They are now saying that they will use the channel primarily for HDTV but would also like permission to use it for other services. In 1995, the new chairman of the FCC, Reed Hundt, voiced concern that the broadcasters, not Congress, should decide how their channels are used as long as HDTV is delivered. The issue is still under consideration.

In addition, there now appears to be some interest by the Japanese in converting to digital. Whether they will ultimately decide to change remains to be seen.

All of these issues are beginning to cause the general public to ask questions, most of which center around the use of their existing equipment — from TV sets to VCRs and camcorders — after HDTV arrives. The answers appear to be that non-HDTV VCRs and camcorders will work with new HDTV sets, but the picture quality will be sacrificed. And those hundreds of videotapes containing family reunions and growing children can still be viewed 20 years from now.

HDTV, after years of speculation, is finally becoming a reality. When available to the general public, it will result in larger television sets with sharper, more detailed pictures and high-quality sound. The introduction will necessarily be slow due to high initial costs and the complete changeover of technology. It is a change that won’t occur overnight, but one that will happen.

u contributed by Linda Stranahan

Hollerith, Herman (1860 – 1929)

American inventor, best known for devising a system for encoding data on punch cards and a tabulating machine to process the data, which were instrumental in development of the digital computer.

Born in Buffalo, New York, in 1860, Hollerith was educated at Columbia University School of Mines. After graduating in 1879, he began working for the U.S. Census Bureau as a statistician for the 1880 census. Although holding several other jobs over the next decade, he continued to experiment with automating census tabulation, a problem whose importance grew along with the country's population.

Under pressure from Congress to increase the information obtained in the 1890 census, the Census Bureau held a competition to find a quicker and more efficient tabulating method. Hollerith easily won the competition with a fast and reliable invention combining ideas from Joseph-Marie Jacquard's loom and Charles Babbage's Analytical Engine. It included a paper card, clipped on one corner, and designed with 288 locations for bits of information. The card was encoded by a keypunch machine and read by a pin press.

Using Hollerith's invention, the 1890 census was the first major data processing project to incorporate electricity. Despite a dramatic increase in population, the 1890 census required less than one-third the time it took to complete the previous census.

Hollerith's next venture was founding the Tabulating Machine Company in 1896. It was immediately successful and supplied tabulators for many business applications and census analyses in Europe and Russia. The U.S. Census of 1900 was processed using Hollerith's newly devised automatic card feed, but a financial dispute finally ended his long association with the Census Bureau. After a series of acquisitions and phenomenal growth, in 1924 Hollerith's business was renamed International Business Machines (IBM) under CEO Thomas J. Watson.

u contributed by Kay S. Volkema

Home Shopping

A method by which consumers purchase goods and services from television channels dedicated to selling products or from on-line computer service providers.

The concept of home shopping may be as old as the first Sears and Roebuck catalog, which in 1887 enabled Americans to purchase the necessities of life by mail. Though Sears ceased publication of its "Big Book" catalog in 1993, catalog shopping is still around and going strong, and the electronic age has made home shopping increasingly sophisticated. With a telephone, television or computer (and of course the money), consumers can obtain a wide range of goods and services without stepping outside their homes.

Today, home shopping television networks, commercial on-line services and even the Internet offer electronic alternatives to the traditional marketplace. And with advances in communication networks on the horizon, home shopping promises to become even more popular with consumers.

Home Shopping Networks

Today, home shopping networks represent a $2.5 billion dollar retail market. Their power to quickly sell a high volume of merchandise is unprecedented. For example, one home shopping network, QVC, sold 5,400 suede bomber jackets priced at $79.95 each in just 20 minutes. On another occasion the network sold 12,000 Diane Von Furstenburg blouses priced at $59.98 in roughly the same amount of time.

However, when Home Shopping Network (HSN) debuted in 1985 as the first national home shopping network, industry experts scoffed. The idea of using television channels exclusively to sell products had been around for more than a decade. In fact, Warner-AMEX launched an interactive television service in Columbus, Ohio, in the late 1970's called QUBE that offered a home shopping channel. The project never expanded beyond the Columbus area, however, and by 1981 Warner had abandoned QUBE altogether.

HSN's strategy in 1985 was to reach a national audience via cable television and satellite dishes. The network sold items that it had obtained cheaply through overstocked wholesalers or from forced stock liquidation. That, combined with the network's low overhead, generated $17 million in profit on revenues of $160 million in that first year.

Because of HSN's success, more than a dozen companies entered the home shopping market by the end of 1986. Few survived very long. Through mergers, buy-outs and consolidations, today there are only two major home shopping networks, HSN and QVC (though each runs two separate networks). Part of the reason so many home shopping networks failed to survive was their weak market penetration; There is a direct relationship between how many viewers a particular home shopping channel reaches and its gross profit. Home shopping networks offered cable operators incentives for carrying their channels in the form of a payment for each viewer the cable system serviced (in the area of 25-50 cents per viewer) or in the form of a percentage of the network's equity. This gave cable operators who owned a large stake in a particular home shopping network the incentive to carry that channel on their cable systems.

Though there has been a recent resurgence in companies starting home shopping networks, such as NBC, Macy's, Black Shopping Network (BSN) and a host of others, these new entrants have a technical problem to overcome: cable systems have a limited amount of channel space and may not be able to offer new channels to their customers. Therefore, new start-up home shopping networks may have trouble reaching a large enough audience to be successful. Networks such as MTV and Nickelodeon's Nick at Nite have experimented with home shopping programs. This limited approach to home shopping may be more successful than starting entire home shopping networks because existing networks like MTV and Nickelodeon do not require a separate channel in order to sell products.

On-Line Shopping

Though television networks are the most popular, as well as the most profitable, method of electronic home shopping, shopping by computer is gaining a foothold in the retail market. On-line services such as Prodigy, America Online, GEnie, and other subscription-based computer services offer their customers home shopping opportunities. In 1994, on-line retailing garnered $200 million in sales. One research firm estimates that that number could reach $4 billion by the end of the decade.

Generally speaking, an on-line service "rents" space to a retailer, much like a shopping mall owner rents space to retailers. Space on an on-line service amounts to a location on a computer network. In addition to rent, the retailer pays a percentage of profits to the on-line service. A range of products are sold in this way, including computer hardware and software, books and CDs. In fact, one of the most popular retail services, has been floral delivery. Using their computers, customers can see what a floral arrangement looks like, order it, and have it sent anywhere in the country.

The success of these commercial ventures has led to an expansion of on-line home shopping. Though commercial ventures and advertising on the Internet have been frowned upon by long-time Internet enthusiasts, retailing has managed to find a niche. The Internet is basically a computer cooperative. Unlike commercial services, it is a loosely connected network of computers that no single entity owns or controls and for which no one takes responsibility. Through the World Wide Web (WWW), a part of the Internet that offers a wide range of information, retailers have been able to set up retail "sites" to sell products and offer promotional material for their companies. The medium allows advertisers to create special promotions that take advantage of a computer's unique ability to communicate information. For example, Oscar Mayer Foods allowed WWW browsers to download a 60-second video promoting its products. Though these sites could easily be lost within the multitude of sites already existing on the WWW, companies that sell navigational software for the Web have struck deals with companies that wish to use it for commercial purposes.

Navigational software gives users some idea of what the WWW offers and how to access it. These navigational programs list advertisers' sites as places of interest. These special promotions, along with the navigation software, help the advertisers create interest in their sites.

An ongoing concern of those who do business on the Internet is security. Because information sent through computer networks may be vulnerable to electronic eavesdroppers, there is concern that credit card numbers may not be protected if used to purchase items on the Internet. To eliminate this fear until more sophisticated security systems can be developed, retailers often use telephone confirmation when orders are placed via the Internet.

The Future of Home Shopping: Interactive Television

As communication becomes increasingly sophisticated, so will the way businesses sell their products. Interactive television promises to offer consumers the ability to shop with the aid of their television sets. It is expected that people will be able to view items, purchase them and have them delivered to their homes using a remote control pointer. Some of the shopping services envisioned in such a system include video grocery shopping, virtual test drives for car buyers, and comparison shopping.

Because these systems will incorporate sophisticated computers, consumers may be able to perform specialized retail searches, such as seeking out the lowest price on snow tires or finding every used car available for a specified amount.

Already there are numerous types of interactive home shopping systems (also called transactional television), though they have been deployed on a limited or experimental basis. Time Warner's Orlando, Florida-based Full Service Network (FSN) is one such venture. FSN is a testbed for digital television. Such small-scale tests provide Time Warner and other companies that are testing these types of advanced television services the chance to work out technical bugs as well as to understand how consumers react to interactive services. Offering consumers digital services like video on demand, where viewers have access to a library of videos instantly, FSN also allows immediate access to retail product information. FSN subscribers will have access to on-screen catalogs that they can browse at will. This gives viewers more control than is offered by traditional home shopping networks, where viewers must sit through presentations of all products offered until they see one in which they're interested.

Many other companies are experimenting with home shopping networks without the complex digital network that FSN uses. One such company, called Interaxx, is testing a system that uses a traditional cable system in combination with a computerized set-top box at the consumer's home and a telephone connection. Consumers receive a computerized set-top box with a CD-ROM drive, and a CD-ROM catalog of products. When connected to their cable television line, the CD-ROM catalog shows viewers current product information, such as price or availability. If the viewer decides to buy a product, he or she uses a remote control to select the product; credit card information is then sent over telephone lines to a computer that processes the order and bills the consumer's credit card.

Hotels have also begun to experiment with transactional television in hotel rooms. The services include electronic clothing catalogs and floral delivery. Hotels could also offer city maps and other services of particular use to travelers.

Though some futurists have envisioned home shopping services eventually replacing the local supermarket or shopping mall, others remain unconvinced. In particular, retailers who have ventured into the home shopping market have said it is simply another avenue for them to sell their products, not a replacement for existing methods.

u contributed by Christopher LaMorte, with Vladina Hess

Hopper, Grace Murray (1906-1992)

American mathematician and naval officer, primarily known for her pioneering work in computer programming and data processing.

Hopper was born in New York City in 1906, and educated at Vassar College and Yale University. She taught mathematics at Vassar for a number of years, then joined the U.S. Navy in 1943 in mid-World War II. In 1944, the Navy assigned her to Harvard University to work with Commander Howard Aiken's team on the construction of the Mark I, the country's first programmable computer.

Having lost her husband in the war, Hopper immersed herself in programming the historic Mark I, which she called "the monster." During this time she originated the term *debug,* after finding and removing a dead moth that was causing problems in one of the computer's relays. She also helped program the Mark II and Mark III.

After the war, Hopper worked for the Eckert-Mauchly Computer Corporation (later part of Sperry Rand) and continued her military service in the U.S. Naval Reserve. In 1952, she devised the first high-level language compiler to translate computer instructions from English to machine language. From 1959 to 1961, she also spearheaded the development of COBOL (Common Business-Oriented Language) for business computer use.

Hopper spent the 1960's teaching and lecturing. She retired from the Naval Reserve in 1966, but returned to help supervise the Navy's overhaul of its computer programs and languages. By special act of Congress, Grace Murray Hopper received the rank of captain in 1973 and rear admiral in 1983. She retired from the Navy for the second time in 1986 and then consulted with the Digital Equipment Corporation. Hopper, a pioneer in computer programming and data processing, died in 1992.

u contributed by Kay S. Volkema

Hostetter, Amos B, Jr. (1937 –)

American entrepreneur who, at 36, was the youngest person ever elected Chairman of the National Cable Television Association (NCTA). He also built the country's third largest cable company and instituted a commercial-free, educational cable service, *Cable in the Classroom*. Hostetter is currently Chairman of Continental Cablevision, one of the top multiple-system cable operators (MSOs) in the U.S.

Relatively unknown outside of the cable industry, Amos B. Hostetter, Jr. has built Continental Cablevision into one of the largest operators of cable television systems. It was founded in 1963 by Hostetter and his fraternity brother, H. Irving Grousbeck. The son of a Wall Street executive, Hostetter grew up in stylish Short Hills, New Jersey. After Pingry School, he went on to Amherst College where he received his BA in 1958, and then went to Harvard Business School, from which he received an MBA in 1961.

Hostetter started his company by building cable systems in the underserved markets of Tiffin and Fostoria, Ohio. The company expanded rapidly by building new systems and acquiring other companies, such as McClatchy Cable in 1986, American Cable Systems in 1988 and the Providence Journal Company cable systems in 1995. In 1980, Grousbeck left when Harvard offered him a professorship (he moved on to Stanford in 1985). Today, with Hostetter at the helm, Continental Cablevision now serves more than 4.1 million customers in 20 states.

As Chairman, Hostetter held tight private control for many years despite countless opportunities for his company to go public. One rival said Hostetter had the "guts to stay private." It wasn't easy. He is fiercely independent and willing to take risks, and took on an enormous debt load to finance growth while preserving his equity. In the mid-1980's, Hostetter personally leveraged his holdings to buy out a stake he had previously sold to Dow Jones & Co. Continental finally became a public company in 1995 through its acquisition of publicly-held Providence Journal Company cable systems.

Continental Cablevision is one of the first cable companies to install high-capacity fiber-optic transmission systems. The company has made a major commitment to this new technology, installing several thousand fiber-miles each year. Continental Cablevision is a founding member of CableLabs, an R & D cooperative that is developing and testing new technologies that promise to fundamentally transform the business of television.

Hostetter's commitment to Continental Cablevision has resulted in it becoming a model corporate citizen. The company's stated objectives are to provide customers a rich variety of quality programming at fair and affordable prices and to provide a level of customer service that is second to none. In 1988, 1989, and 1990, Continental Cablevision was named the industry's "Operator of the Year" by the readers of *CableVision* magazine.

Community service is also important to Hostetter. One example of his commitment is his involvement with the industry-wide education initiative, *Cable in the Classroom*, which provides schools with free, copyright-cleared programs obtained from the leading educational television producers. *Cable in the Classroom* brings the world to the students through quality programs from CNN, The Learning Channel, Discovery, C-SPAN, Arts & Entertainment and other national cable networks. Because Hostetter and his cable industry colleagues believe the classroom should be a place for learning and not a forum for advertising, *Cable in the Classroom* programming is commercial-free.

In recognition for his lifetime contributions to the communications industry, Hostetter was named to *Broadcasting* magazine's Hall of Fame. For his contributions to the industry's public affairs efforts, Cable Television Public Affairs Association awarded him the Crystal Beacon. In 1993, he was awarded the Grand TAM award from the Cable Television Administration and Marketing Society and was recognized by the Walter Kaitz Foundation for his exceptional efforts to increase the diversity of cable's work force. Harvard Business School presented Hostetter with an Alumni Achievement Award in 1994.

Hostetter is reported to be a rare combination of entrepreneur and Yankee conservative. He didn't marry until his late 40s and his only two children are still in school. Hostetter and his wife Barbara's only real bow to wealth is a vacation house in Nantucket.

u contributed by Diana L. Hollenbeck

House, Royal Earl (1817 – 1899)

American who invented electrical devices, such as the glass screw socket insulator; he is primarily known for inventing the printing telegraph.

Shortly after House's birth in 1817, he and his family moved from Rockland, Vermont, to Susquehanna County, Pennsylvania. Throughout his childhood, House demonstrated his aptitude for mechanics and science by conducting experiments and devising instruments, such as the submerged water wheel known as the scroll wheel. He had the remarkable capacity to formulate the mechanical details of his inventions without rendering them in drawings. A month before his twenty-fifth birthday, he secured a patent for a machine to saw barrel staves.

House abandoned his intention to study law in favor of experimenting with electricity. From 1840 to 1844, he focused on creating a means to record telegraph messages in printed Roman characters. After he mentally devised the printing telegraph, he commissioned several shops to build parts of the machine and then assembled them himself.

The apparatus consisted of a keyboard, a single line of insulated electric conductors, magnets, type wheels, automatic platens and paper carriers. Operators sent messages by depressing keys on the machine's piano-like keyboard. Its black keys represented the letters A to N; its white keys, the letters O to Z, period, and hyphen. Receiving instruments rotated type wheels to the characters designated by incoming signals and pressed a paper tape against them, thus printing the messages in Roman letters.

In the autumn of 1844, House demonstrated his printing telegraph at the American Institute Fair in New York, at which he obtained sufficient funding to perfect his invention. Two years of additional development resulted in an instrument capable of printing more than 50 words a minute. House patented his printing telegraph on April 18, 1846. Representatives of the Morse patent sued him for infringement of patent rights, but their efforts proved unsuccessful.

Meanwhile, in November 1846, Hugh Downing, Henry O'Reilly and Judge Samuel L. Selden bought the right to use his patent on the Atlantic and Ohio telegraph line. The following autumn, O'Reilly sent the first telegram by House telegraph printer.

In late 1847, Downing obtained additional patent rights for the Atlantic seaboard and New England. Likewise, Selden obtained rights for the state of New York and an option for the rest of the country, which he exercised later. Under terms of the agreements, House and his partners received one-fourth interest in all lines that operated using House instruments.

House also participated in planning the construction and installation of the lines. His recommendation to use stranded wire made it possible to span the Hudson River at Ft. Lee, New York, and install permanent telegraphic communication between New York and Philadelphia. By 1855, an extensive network of telegraph lines equipped with House printing telegraphs stretched along the Atlantic Coast from Boston to New York and Washington, and west to Cleveland and Cincinnati.

With consolidation of competitive telegraphic lines during the 1850’s, House’s printing telegraph gradually went out of use. He continued to invent electrical devices, including a glass screw socket insulator and the machine to produce it. In 1885, he moved to Bridgeport, Connecticut where he resided until his death in 1895. He was married to Theresa Thomas of Buffalo, New York.

u contributed by Nancy Muenker

International Business Machines Corporation (IBM)

Pioneer and leading manufacturer of computers in the U.S. and among the leaders internationally. Also produces information handling systems, and office products and equipment. Headquartered in Armonk, New York, IBM is considered one of the world's most powerful corporations.

In 1896, American inventor Herman Hollerith founded the Tabulating Machine Company, which produced tabulators using encoded punch cards for business applications and census analysis. In 1911, this small firm consolidated with two others to become the Computing-Tabulating-Recording Company under new owner Charles Ranlett Flint. Three years later, Thomas J. Watson assumed the presidency of the struggling company , which then employed 235 people in manufacturing electrical punch-card computing systems and other products.

With 18 years previous experience at National Cash Register, the 40-year-old Watson brought to the company business machine knowledge, industry savvy, marketing skill, and strong leadership. He focused on the sales staff, keeping them motivated, well trained, well paid and appropriately dressed to his "code." He also instituted a crucial research and development program.

After more than tripling the company's revenues in ten years, Watson became chief executive officer in 1924. IBM was then the largest producer of time clocks in the U.S. With daring and confidence, he renamed the company International Business Machines Corporation (IBM).

By 1936, IBM manufactured 85 percent of industrial-sized tabulating machines, prompting the Supreme Court to void some exclusionary demands that IBM had made on its customers. Despite the judgment, IBM flourished financially as it supplied tabulating equipment to an expanding bureaucracy.

Over the following decades, Watson successfully pursued business opportunities worldwide for IBM. Entering the fledgling computer industry in 1939, IBM sponsored Commander Howard Aiken's project at Harvard University, which culminated in the invention of the Mark I, the country's first programmable computer. Formally named the IBM Automatic Sequence Controlled Calculator, the 35-ton Mark I was the forerunner of the modern electronic digital computer.

In 1952, Watson turned the prosperous company's leadership over to his son, Thomas J. Watson, Jr., while Watson, Sr. acted as Chairman until his death four years later. At the time, IBM employed 60,000 people in 200 offices. Heavily into research and development, IBM was also deeply committed to repairing and servicing equipment bearing its name. The younger Watson strategically dedicated the company's considerable resources to developing computer equipment and becoming a leader in this new field. So for the next two decades, IBM dominated the international mainframe market. Led by Watson until 1971, IBM continued to enjoy substantial growth and financial success. But competitors were gaining ground in minicomputers.

By the late 1980’s, IBM was the world’s largest producer of a full line of computers, office equipment, and integrated circuits. During this time, John F. Akers became Chairman. He resigned in early 1993, however, after reorganizing the company into more autonomous business units, eliminating 40,000 jobs a year earlier and still posting record financial losses. IBM is now run by Chairman and CEO Louis Gerstner, who has joined forces on projects with such top telecommunications companies as Apple Computers and Motorola in an effort to stay abreast of the competition.

Over the years, IBM often was at the forefront in advancing technology. In the mid 1920’s, it developed and marketed the first electric typewriter. In the 1950’s, IBM introduced the 700 series of computers in response to Remington Rand’s UNIVAC. The company’s first transistor calculator appeared in 1955. The next year, an IBM team led by John Backus developed FORTRAN, the first scientific computer programming language. In 1964, IBM launched its popular 360 series of mainframe computers and solidified its industry leadership. Three years later, the company began selling hardware and software as separate units, opening up a huge new market for the latter. In 1981, IBM successfully introduced its Personal Computer (PC), still considered a standard.

Today, IBM is the largest manufacturer of data processing machines and systems in the world. When Thomas J. Watson, Sr. boldly named the company International Business Machines in 1924, he successfully foresaw and then proceeded to shape the future for this industrial giant.

u contributed by Kay S. Volkema

Independent Phone Companies

Local service telephone companies that are not affiliated with one of the Bell telephone companies. Independent telephone companies have been around almost since the invention of the telephone in 1876. Although relegated to the background of the industry during the 100 years of AT&T's telephone monopoly, these non-Bell companies are making a comeback since the 1984 breakup of the Bell System. As pressure increases to open the local service market to competition, strong players are arriving on the scene, and some small independent companies are beginning to grow. The independents are represented by the United States Telephone Association (USTA), the National Telephone Cooperative Association (NTCA), and the Organization for the Protection and Advancement of Small Telephone Companies (OPASTCO).

History

Even as Alexander Graham Bell was patenting his telephone, others were trying to get into the new telephone industry. Bell's first competition came from Western Union, which set up its own telephone company using inventions by Thomas Edison. The early years of the telephone industry saw the development of hundreds of independent companies, each usually serving a small geographic area. As the number of telephone customers increased and as AT&T grew stronger, many of these independent phone companies were purchased and absorbed into the Bell System. During the 100 years of AT&T's virtual monopoly of telephone service, only a few independent companies survived. These usually provided service in small, rural areas that were not seen as particularly profitable by AT&T. But this was not true of all independent companies. General Telephone and Electronics (GTE) managed to maintain some fair-sized independent companies and resisted the lure to join the Bell System.

Independents Today

With the 1984 breakup of the Bell System, the stage was finally set for the independent companies to assert themselves. AT&T, having retained the long-distance portion of telephone service, was now subject to competition from other long-distance carriers. The regional Bell operating companies (RBOCs), which handled only local service needs, were still regulated by the government. In the years following the breakup, there has been increasing pressure to drop all regulation and open the entire telephone industry to competition. Recently, many of the small independent companies have been joining together in consortiums, alliances and mergers to have a stronger voice in the direction the telephone industry will take. Other independents have joined forces with cable television (CATV) companies and long-distance carriers, who want to get into the local telephone business. These new alliances give the independents the resources they need to grow.

Although most of the independent phone companies were located in small, isolated or rural areas, this sometimes worked to their advantage. Because the independents were not part of the Bell System monopoly or the post-divestiture RBOCs, they were not subject to all of the regulations that inhibited those companies from expansion into new areas. And because the independents were small, they were able to test some new products and services without a major investment, a condition that sometimes prohibited or delayed the

RBOCs from trying the same thing. Following are examples of what some independent companies are doing:

u GTE, Southern New England Telephone (SNET) and Rochester Telephone are all planning and testing interactive video services. Starting with the test of a broadband system in Cerritos, California, GTE plans to offer interactive video services to six to seven million people by the year 2004. SNET is developing a voice, data and video network with AT&T that will eventually connect over 500,000 customers. Rochester Telephone is preparing to test video services in 120 Rochester, New York, homes and plans to expand service to 900 access lines. (Some RBOCs are also beginning to explore video offerings in portions of their service areas.)

u Com Net, a consortium of 19 Ohio-based independent telephone companies, has embarked on a project to provide Ohio subscribers with toll-free access to information services, electronic mail, bulletin boards and the Internet.

u Conestoga Telephone and Telegraph Company in Pennsylvania is currently serving more than 38,000 subscribers with voice mail; radio paging; and voice, data, and cellular services.

u Colorado's 33 independent telephone companies have installed fiber-optic networks that rival and sometimes exceed the state-of-the-art service of the larger companies.

u GTE (which owns several independent phone companies across the nation) is experimenting with broadband fiber-optic networks; is using satellite capabilities to operate networks for K-Mart, Federal Express, Eastman-Kodak, and others; and is coordinating intelligent network arrangements with cellular services.

u GTE and others are experimenting with completely wireless communications in small communities, which could herald a new direction for the telephone industry.

New Players

Another interesting issue for independent phone companies is the number of outside entities that are trying to enter this market. Competitive access providers (CAPs), which came into existence after AT&T's divestiture, provide alternate local service access to long-distance carriers, primarily for large businesses. Lately, their focus has begun to change, and they are now looking at how to get into the local exchange service business. With the inevitable lifting of restrictions and regulations in the local exchange service, many of these companies will enter the marketplace and, in essence, become independent phone companies. But, also with the lifting of regulations, the term "independent phone company" could become unnecessary; there could be any number of companies, all of them independent, and all of them competing for local residential and business service.

Summary

Historically, an independent phone company was any company offering local telephone service outside the Bell System monopoly or, since the 1984 divestiture, outside any of the established RBOCs. With the potential deregulation of the telephone industry and the large number of players now wanting part of the local service market, almost any firm can become a telephone company, and all will be independent.

u contributed by Linda Stranahan

Infomercials

Long-format television commercials used as extended advertisements for a range of products and services.

Though sometimes disparagingly referred to as the "B-movies of commercials," no one denies the success of the infomercial. Since 1984, when President Ronald Reagan removed restrictions on broadcasters that prevented them from airing more than 12 minutes of advertising per hour, these long-form commercials have developed into a billion dollar industry. The infomercial industry also created significant revenue for television networks as well as for those involved in producing infomercials.

Originally, infomercials were long-form direct-response commercials. Direct response commercials are those that request consumers to call or send money to receive a product in the mail, as opposed to commercials that request consumers to buy a product at a store. Typically, direct-response radio and television ads rely on a "hard sell" approach that emphasizes the product's value and its "limited availability." This type of advertising has been used for years in 30-second and 60-second broadcast commercials, often employing a fast-speaking spokesperson who almost invariably warns viewers: "This product is not available in stores, so act now!"

Infomercials simply lengthened the amount of time an advertiser had to sell the product. An infomercial can be as short as 2 to 3 minutes or as long as 30 minutes.

Infomercials took advantage of this extended time period by using a recognized television format to sell a product. Usually appearing in the early morning and other time slots with low viewership, infomercials were modeled after talk shows, news programs and even situation comedies. Some consumer advocacy groups, however, denounced these formats because they felt consumers were misled into thinking they were watching non-commercial programs.

Though these infomercials usually appeared in obscure time-slots, the unique products they promoted often caught America's attention. For example, GLH (Great Looking Hair), an aerosol spray-on hair product marketed to those with thinning hair became a nationally known product, although it was often advertised during the middle of the night.

Soon, however, infomercials moved beyond the realm of direct response. Advertisers used them to sell a corporate image, a retail product, or even a personality. Texas billionaire H. Ross Perot, for example, purchased hour-long prime-time advertising slots on national networks to make direct appeals for votes in his unsuccessful 1992 run for U.S. President.

As advertisers recognized the power of infomercials to catch the viewer's attention, the format became more widely accepted by larger companies and by broadcasters. It is now estimated that 450 to 500 new infomercials are created every year. Additionally, 9 out of 10 cable and broadcast operators air infomercial spots, creating a $400 million revenue stream for the television and cable industries. In 1994, sales from products advertised on infomercials reached $1 billion.

But as infomercials became more widely accepted and as large corporations began to use them to carefully control their corporate image and the presentation of their products, the cost of producing infomercials increased. In the mid-1980's, an advertiser could expect to spend $100,000 to produce a 30-minute program, in addition to the cost of airing it. In the early days of infomercials, a 30-minute segment of airtime during low-viewership hours sold for $2,000 or less. In fact, some broadcasters provided free airtime for infomercials. Today, however, the average cost of producing an infomercial is $250,000 to $300,000 or more, with the average cost of airtime ranging from $5,000 to $20,000 for a 30-minute spot.

Because of their length, infomercials are ideally suited for selling products with many functions or features that take time to explain. The full range of a product's versatility can be explained in painstaking detail, allowing the advertiser to emphasize how it can make a difference in the viewer's life. Kitchen aids, cosmetic products, psychic hotlines and self-improvement tapes are common products utilizing infomercials as a direct-response medium.

The popularity of this advertising format helped spawn a cable channel exclusively devoted to it. The Product Information Network (PIN), started in late 1993, is a 24-hour infomercial channel. The network includes infomercials from Fortune 500 companies as well as smaller manufacturers.

By blending entertainment with advertising in an infomercial format, advertisers may be able to make the most of their advertising dollars. They are able to keep a viewer's attention for longer periods of time and become the center of attention, unlike 30-second commercials that interrupt entertainment programming.

u contributed by Christopher LaMorte

Input Devices

External devices and/or computer peripherals that convert text, graphics, or other data into binary language that computers can understand. Most devices require some type of human interaction to begin the input process.

Computers are not able to take in and process information in the same way that humans can. Computers need external devices to import data into their processors and memory banks. Known as input devices, they include the keyboard; pointing devices, such as a mouse or trackball; electronic pens; touch screens; voice recognition systems; modems; scanners; and video and audio processing cards .

Keyboards

Many long-time computer users are so accustomed to the keyboard that they consider it an extension of themselves. Keyboards are based on a design similar to the QWERTY typewriter; both require that users touch keys to store information. But, keyboards differ from typewriters in many ways. They electronically translate human readable symbols (letters, numbers, and punctuation marks) into binary encoded equivalents the computer can use. These binary pulses travel from the keyboard to the system's random access memory (RAM), where the data is stored until it is used or stored on a hard drive or floppy disk. Keyboards usually have several more keys than the average typewriter so that special computer commands can be entered.

Pointing Devices

After keyboards, mice are the most frequently used input devices. Originally, the mouse was designed as a simple pointing device, something users could move with their hands to cause a reaction on the screen. Apple Macintosh computers were the first to make mice standard features. Since then, the technology has been adopted by most computer manufacturers.

As the user drags the mouse over a flat surface, a ball visible at the bottom of the mouse turns in the direction of the movement. It touches and turns two rollers mounted at 90 degree angles to each other. Each roller responds to either a back-and-forth or side-to-side movement that is echoed on screen.

In one system, the rollers are attached to a wheel known as an encoder. As they move, they rotate the encoder, which is connected to tiny metal contact points on each side. Each time a contact part touches a point, it sends an electrical signal to the computer indicating the movement. The more points, the further the mouse has traveled. Tapping one of the buttons on top of the mouse sends a command to the computer to operate certain functions of the software. Software determines the meaning of the movement.

Trackballs and joy sticks operate on a similar principle. All act as pointing devices and create action on the screen based on hand movements. While neither of these devices will replace the keyboard, they do make it easier to point to objects, move files, and carry out simple computer functions.

Electronic Pens and Tablets
A relatively new type of input option is the pen-based system. A pen-based system is made up of an electronic pen and touch-sensitive screen. Users can handwrite messages, check boxes, and cross out mistakes directly into the computer. Pen-based systems are also used in some personal digital assistants (PDAs).

Pen-based computing is ideal for mobile professionals who do not have access to a full-sized computer. Keyboards and mice require a great deal of space to use, but pen-based systems can be used anywhere with minimal space requirements. Unfortunately, pen-based computers have a number of problems, including inaccurate reading of data and short battery life. While they will likely be an important trend in the future, users have not flocked to this type of device.

Digitizing tablets are quite similar to pen-based computers. Users can write, draw or trace designs on top of a pressure-sensitive pad with an electronic pen. Typical users are artists and graphic designers.

Touch Screens
Touch screens work on a principle similar to electronic pens. Sensors on the screen recognize the touch and translate it into electronically coded impulses. One common type of touch screen is found on a kiosk. Usually located in public places, kiosks often provide information about tourist destinations, restaurants, government offices, and shopping centers.

Voice Recognition Systems
Probably the most controversial input option is the voice recognition system. With voice recognition, a microphone is attached to the computer system. The user speaks a command, such as “Open ABC file,” into the microphone, which digitally converts the sound into a computer command. The computer then compares the sound pattern data to stored patterns, trying to find a similar one. If it finds a match, the computer can carry out the instruction set that corresponds to the spoken command.

Voice recognition will be an extremely useful option once problems with accuracy and reliability are resolved. Currently, each individual computer must be trained to recognize its user’s voice; the voice speech patterns and accent of other individuals are often unrecognizable. Another drawback is that because computers have a limited vocabulary, they are only able to recognize simple commands, such as “save file” or “exit.”

Modems
Modulator-demodulators, or modems, process computer data so it can be sent or received from the public switched telephone network (PSTN), and as such serve as an input device. These devices convert analog tones into a digital signal that is used by computers to import files, programs, and even commands. A modem is unique in that one device serves as both an input and an output device — simultaneously!

Scanners
Yet another way computers can input written text and graphics is by using a scanner  or digital imaging system. Both devices translate images using optical character recognition (OCR). OCR first translates pictures and text into a series of black and white dots known as a bitmap. These dots are electronically stored in the computer as an ASCII,

or plain text file. Scanned and imaged text can then be added into an application program, such as a word processor or graphics program.

Scanning or imaging a document frees the user from rekeying data. Unfortunately, OCR packages are far from error-proof. Files created from OCR systems frequently contain errors or mistakes that occur in the translation. The user must proofread the document to make sure everything has been read properly. OCR works best with clean, evenly spaced text and is least reliable with handwritten text, smudged documents, or decorative fonts.

Video and Audio Processing Cards
Today, there are special, still rather expensive, video and audio processing cards. These cards contain special input circuits which digitize video and audio signals. Once converted to a form the computer can understand, a final video and/or audio product can be produced. Usually these systems can work with small segments of the original program, add special effects and electronically edit. These devices, like modems, are often input and output devices.

Regardless of which input devices a user chooses, they are a necessary part of the computer environment. As time goes on, changes will be made to existing products as new devices come on the market.

u contributed by JDC Editorial Staff

Integrated Circuits

An integrated circuit combines various electronic components on one small silicon wafer called a chip, enabling electronic devices such as computers to become smaller and faster.

Prior to the invention of integrated circuits, computers faced a major encumbrance their size. Originally, electronic computers used vacuum tubes to switch electric signals. ENIAC, the first widely recognized all-electronic general purpose computer, used nearly 18,000 of these tubes. As a result, the machine was enormous, weighing over 30 tons. The heat generated by these tubes was also considerable, causing frequent breakdowns and component burn-outs. The advent of the transistor in 1948 greatly reduced these problems.

The transistor was smaller than the vacuum tube. By the time the transistor made its debut, computers had increased in their electronic complexity, some consisting of over 200,000 different electrical components. Wiring all these individual components together was exceedingly difficult and expensive. In the late 1950’s, Jack Kilby, an engineer with Texas Instruments, solved this problem by creating one electric circuit that combined various electronic components on a thin silicon slab.

Since the time Kilby hand-wired the first two-component integrated circuit, the amount of electronic components squeezed onto one silicon dime-size wafer, or chip, has dramatically increased. Large-Scale Integration (LSI) managed to put hundreds of components onto one chip, an area roughly the size of a U.S. dime. By the 1980’s Very Large-Scale Integration (VLSI) and Ultra-Large-Scale Integration (ULSI) could fit hundred of thousands or even millions of components onto a single chip. Engineers accomplished such feats by taking a silicon disk and layering on it a light-sensitive material with a circuit design etched on it through a photochemical process. This disc is then divided into individual chips. As the complexity of integrated circuits increased, their price and size diminished even as the power and efficiency of the machines they operated increased. Integrated circuit design is at the heart of modern electronic devices, such as kitchen appliances, computers, digital watches and calculators.

u contributed by Christopher LaMorte

Integrated Services Digital Network (ISDN)

A telecommunications technology that uses the public telephone network to provide end-to-end digital connections. ISDN can simultaneously transmit information in a variety of forms, such as voice, data and video.

Although much of our world is becoming increasingly digital, some of the methods of transmitting data remain largely analog. Digital information can be represented as a series of ones and zeros, while analog information is represented in the form of a continuous wave. Telephone companies have implemented digital technology in much of their networks. However, the local loop, the segment of the telephone network that connects to telephone users, still uses analog methods to transmit data.

This means that when computers, for example, share information over standard telephone lines, the digital data that computers understand must be converted into an analog signal. As this analog information reaches its destination, it then is converted back into a digital form. A modem is the device a computer uses to make this conversion.

However, a computer adapted with the proper ISDN-interface equipment doesn't need a modem to transmit information. Digital information is sent directly from one computer to another (or any other digital communication device).

Other technologies are able to provide phone customers with end-to-end digital connections, such as installing digital data service (DDS) between two points. Customers utilizing DDS, however, must pay a flat rate for those lines, regardless of how much they actually use them. Therefore, for phone customers who only occasionally need an end-to-end digital connection, dedicated lines will probably cost too much. ISDN service, by contrast, works over the public switched telephone network (PSTN) — the same network that handles conventional telephone connections. Customers only pay for the time they actually use ISDN service. Additionally, information can also be routed through a packet-switched network, which is often used for digital data transmissions.

Another benefit of ISDN is its ability to provide a common line for the simultaneous transmission of different types of information. For instance, a home office without ISDN service may need three separate telephone lines: one for a telephone, one for a fax machine and one for a computer modem. The alternative is to have just one line and switch the devices as needed. ISDN, however, allows all of these devices to share a common line, using time-share technology.

How ISDN Works

The standard for ISDN was developed in 1984 by the Comitè Consultatif International Tèlègraphique et Tèlèphonique (CCITT), an international communications standards committee. Today that committee's successor, the International Telecommunications Union-Telecommunications Standardization Sector (ITU-TSS) maintains ISDN standards. U.S. corporations have also addressed the standards issue. In 1992 the regional Bell operating companies (RBOCs) and telephone equipment manufacturers agreed to follow a standard, called national ISDN, for deploying ISDN services across the United

States and for making ISDN-compatible equipment. This is a critical concern since the purpose of standardization is to ensure that ISDN facilities designed, built and maintained by different telephone companies are able to interconnect with each other.

The ITU-TSS recognizes two types of ISDN interfaces: the basic rate interface (BRI) and the primary rate interface (PRI). BRI handles 128,000 bits of information per second (128 kbps); PRI 1.472 million bits (megabits) per second. A bit is the smallest part of a digital signal. By contrast, today's fastest computer modems can handle only 28.8 kbps.

BRI consists of three channels. Two bearer channels (B channels) carry voice, data and other information, each at 64 kbps. A data channel (D channel) carries signaling data or other types of routing information at 16 kbps. This D-channel is an out-of-band signaling channel. Out-of-band means the signaling channel races ahead of the B channels on a separate network to ensure faster connections. Signaling channels carry information that helps establish phone connections. These channels may also carry information identifying a particular user (such as a telephone number) or provide other specialized call-handling features.

The primary rate interface carries 23 B channels at 64 kbps and one D channel at 64 kbps. Users with complicated telecommunication or video needs may benefit from this added channel capacity. PRI also offers bandwidth on demand. This feature enables users to employ more B channels at any one time to conduct data transmissions that involve a larger amount of bits per second. Full color, full motion video conferencing, for example, involves exchanging a greater amount of data than a voice-only telephone call. More B channels can be allocated for such data-intensive services.

Special ISDN-compatible equipment is needed for a customer to take advantage of this high-speed network. ISDN telephones and faxes convert voice and print information into digital signals before sending them out over telephone lines. Computers need special interface cards that allow them to plug into ISDN service. Additionally, a network termination device (NT1) and other specialized equipment are often needed to allow communication devices to connect to ISDN service.

ISDN Benefits

Because ISDN service is completely digital with separate channels for data and for signaling, it offers a number of benefits. These include: providing clear voice communications, enabling one phone line to handle as many as 64 phone numbers, allowing different types of communication devices to share one line, and offering special phone handling features. One of the greatest advantages ISDN offers is its speed.

For instance, conventional fax machines work by converting analog information (text, graphics or pictures) into digital information suitable for computer consumption. The fax machine then converts the information into analog waves, which are sent across telephone networks. When the information reaches the receiving fax machine, the analog information is converted back into digital form, which the fax machine then reassembles into a form humans can understand — pictures or text.

All of these back-and-forth conversions take a relatively long time. It takes several seconds to establish a connection and even the fastest fax machines only receive a page or two per minute. ISDN-compatible fax machines, however, can deliver the average-length fax (which is about seven pages) before a conventional machine is finished establishing a connection. And because the system is digital, the end fax is high quality.

This increased speed has particular importance for frequent Internet users. A wealth of digital data — including graphics, videos, music and software — is available through the Internet and commercial on-line services (like CompuServe or America Online). Unfortunately, downloading even short-length multimedia files can take what seems to be an eternity to the anxious “net surfer.” For instance, it can take the better part of a half-hour for a high-speed modem to download a 3-minute high-quality music segment from the Internet. It may take several hours to download a video clip. That is because the modem and analog local loops represent bottlenecks in the data transfer. Today’s fastest modems can only communicate at 28.8 kbps. With a single 64 kbps ISDN connection, this speed is nearly doubled. However, most commercial on-line services have not established ISDN services for their customers.

Other ISDN Applications

Though ISDN technology emerged in the 1970’s, telecommunication engineers took a relatively long time to find ways to put it to use. In fact, some in the industry, frustrated by the lack of ISDN applications, joked that ISDN was really an acronym for “It Still Does Nothing.”

Only after standards were developed in 1984 did telecommunication companies and equipment manufacturers begin to incorporate ISDN technology. In 1992, ISDN development got another boost when phone companies and equipment manufacturers agreed upon the national ISDN standard.

Regional phone companies have spent $100 billion to install ISDN switches and other ISDN-related equipment at their switching facilities over the last decade. Today most major metropolitan centers have almost complete access to ISDN service. All regional telephone companies have ISDN service available on more than 50 percent of their lines; some phone companies offer ISDN service on as much as 80 percent of theirs. Also a few regional phone companies have a service called “ISDN anywhere.” This allows customers who do not have ISDN access in their area to be connected to an area that does.

A high-speed digital network like ISDN offers users the ability to perform a wide range of tasks that a standard analog network does not. Faster data transfer between computers and faster faxing are two advantages of ISDN already discussed. Other benefits of ISDN are discussed below.

ISDN Connections to Local Area Networks

Local area networks (LANs) are groups of computers connected in such a way that each computer in the group can share information and programs as well as support common services such as electronic mail (E-mail). LANs were originally confined to a relatively small geographic location, perhaps to one office or to a small campus. Because conventional analog telephone networks are limited to the amount of data they can send at one time, it was often difficult for outside computers or other networks to hook up to a LAN. Such connections usually required special cable with high data transfer rates.

ISDN, however, now allows remote computer users to access LAN services through the public telephone network. That is because ISDN-compatible computers do not have to use modems, which slow down the rate that data is shared between computers.

This capability is especially useful for telecommuting, the practice of working at home while remaining in close contact with the office through various means. Employees who choose to stay at home to work can plug into their office LAN to easily transfer files and enjoy network services with an ISDN connection.

ISDN Telephones
For placing an ordinary telephone call, the high-speed rate of ISDN is probably overkill. Though digital ISDN connections may provide better sound quality, traditional analog telephone circuits work fine for simple conversations. For business applications, however, ISDN-based telephones offer numerous advantages over analog-based telephones.

Because voice and data communications are integrated, ISDN helps businesses handle calls more efficiently. For example, the data channel provides caller identification information on customers who call in to businesses. Also, instead of having separate lines for a fax and a phone, or alternating between the devices used if they share a single line, ISDN enables businesses to use just one line for different types of transmissions. Remote computers also have the ability to share display information while a conversation is taking place on the same line.

Incoming calls can also be managed by a computer and tracked visually on a computer screen rather than by the flashing lights on a telephone switchboard. This makes it easier for one person to handle many incoming calls. Computers can also be used to log and track telephone call information.

Desktop Video Conferencing
ISDN service has also helped to improve the quality and practicality of desktop video conferencing. This type of video conferencing enables participants to use a personal computer to simultaneously hear and see colleagues at remote locations. Video images, however, represent a tremendous amount of digital information. Desktop video conferencing software compresses video data (digitally manipulates it to make the amount of data smaller). These compressed images can be sent over standard analog telephone lines, but the quality is extremely poor. Analog circuits can send between one and five frames of compressed video every second. By comparison, broadcast television displays 30 frames per second. Video conferencing software designed to work with basic rate interface ISDN is capable of sending about 15 frames of compressed video every second. Though video transmitted over ISDN may not be as good as what one sees on television, it provides a fairly good likeness of video conference participants.

Future of ISDN
Despite the growth in available applications, ISDN still has its problems. Establishing ISDN service has proved logistically difficult in many instances. Also the cost of ISDN equipment and startup fees charged by telephone companies may prove prohibitive to non-commercial users.

Another limitation is that most commercial on-line services still have no ISDN service available to their customers. For instance, ISDN Internet connections, though available, are still problematic. To connect to the Internet through ISDN, users must to go through an Internet service provider that has ISDN access. Such service providers often charge high monthly fees or expensive hourly usage charges.

As telephone companies deploy ISDN on a wider scale, these drawbacks may be eliminated. Whether ISDN will eventually replace analog telephone service entirely, however, remains to be seen.

u contributed by Christopher LaMorte

Intel Corporation

A publicly held company, Intel Corporation is the largest U.S. supplier of computer chips (semiconductors and microprocessors). Headquartered in Santa Clara, California, Intel Corporation is perhaps best known for its Pentium processor chip, which is the brain center of a number of best selling brand-name computers.

Intel Corporation was established in 1968 by Robert Noyce and Gordon Moore, who were part of the original group which founded Fairchild Semiconductor. Noyce and Moore were joined by Andrew Grove , who is current President and Chief Operating Officer of Intel.

The company's original business plan, which was one page in length, stated that it was "going into large-scale integrated circuits." Noyce and Moore originally wanted to name the company Integrated Electronics, but selected Intel when their first choice was already in use.

The company began operation with 12 employees, and had total sales of $2,672 in its first year of operation. Business soon grew as it became a supplier of DRAM (dynamic random-access memory) chips for large computers. Intel had great success with its EPROM (erasable programmable read-only memory) chips. In 1971, the company went public. The success of the public offering provided the company with revenue to develop a series of microprocessor designs. This series began with the 4004 chip in 1971, which was followed by the 8008, the 8080, and the 8088. Pivotal in the success of the company was IBM's decision to use Intel's 8088 chip for its new personal computer (PC) beginning in 1981.

Robert Noyce retired from the senior management staff in l979, but remained on as a Director and Deputy Chairman of Intel's board. Andrew Grove was appointed President and in 1979 and Chief Operating Officer in l985.

In 1985, due to dramatic price cuts in the production of DRAM chips by Japanese competitors, Grove discontinued that part of the company's business. The move forced plant closures and a layoff of nearly 30% of Intel's total workforce. To help the company recover from its losses, Grove steered Intel in the direction of proprietary chip production.

Intel's first series of microchips, the 286, 386 and 486, proved very successful. However, licensing rights given to Advanced Micro Devices (AMD) for the production of the 286 enabled it to capture nearly 52% of the market. Intel went to great lengths to protect its 386 and 486 chips. So much so, that Advanced Micro Devices filed suit against Intel charging it with breach of contract in 1987. Rulings in 1990 and 1992 went against Intel, citing a 1982 agreement with AMD.

Fiercely protective of its chip designs, Intel filed several suits in succeeding years against a variety of companies including AMD, Cyrix and Chips and Technologies. These suits claimed copyright infringement on a variety of products. In 1994, a federal court jury ruled that AMD had a license to copy Intel's microcode, which is part of Intel's 287 math coprocessor.

In 1993, Intel introduced its now-famous Pentium microprocessor chip. During the summer of 1994, the company discovered that the Pentium chip had a flaw when used to execute highly complex scientific and engineering calculations. Slow to acknowledge the defect, Intel President Andrew Grove received a great deal of criticism for the company's lack of response.

Instead of holding a press conference or releasing an urgent news story, actual notification and acknowledgment of the flaw was through a letter that Grove sent to a discussion group that communicated on the Internet. He selected this vehicle for notification because of heated criticism about the flaw that had been rampant on the Internet.

By late 1994, with more than an estimated two million Pentium chips in the marketplace, Intel conferred with its customers, Dell Computer Corporation, Compaq Computer, Packard Bell and others, who used the chip. All were in agreement that Intel should handle replacement of the chip on an individual basis.

To that end, Intel has established a toll-free telephone number to field questions about the Pentium chip flaw. In addition, IBM, another Pentium user, set up an international toll-free telephone number to assist its customers and has agreed to replace the chip based on need.

Also in 1994, Intel introduced its ProShare products. This new line includes live video conferencing with a feature that allows for document viewing and editing simultaneously by two different users.

Undaunted by the Pentium chip flap, Intel has continued its plans to release newer and faster versions of the 500 series and the new 600 series chips. In February 1995, it rolled out its P6 processor, the more powerful successor to the Pentium.

With the introduction of Intel's marketing slogan, "Intel Inside," now seen on many brands of personal computers, the company began its marketing tactic of "branding" its highly successful chips. The future will determine if Intel, under the direction of Andrew Grove, will retain its impressive share of the microprocessor business.

u contributed by Valerie Switzer

Editor's Notes:
A number of major companies are working together to develop Intercast technology, an interactive data delivery medium conceived by Intel. The Intercast Industry Group's goal is to create a service which combines television technology with the World Wide Web, allowing end-users to jump between television shows and web pages with the click of a button on a remote control. Companies involved in the effort include Intel Corporation, Continental Cablevision Inc. (under the ownership of US West), Tele-Communications, Inc., Time Warner Cable Programming, General Instrument Corporation, TCI's Headend-in-the-Sky, NBC, Turner Broadcasting, Viacom International, WGBH Educational Foundation, QVC, America Online, Asymetrix, En

Technology, Netscape Communications Corporation, Gateway 2000, and Packard Bell.

International Telecommunications Satellite Organization (INTELSAT)

INTELSAT is a group of 132 countries that cooperate to utilize and profit from a global satellite communications system. The group was formed in August 1964 and is based in Washington, D.C. INTELSAT designs, develops and maintains the satellites in its system and today is one of the most successful international business cooperatives (co-ops).

The late 1950's and early 1960's were a busy time for communication researchers. Between 1957 and 1960 the United Kingdom, Canada, the Union of Soviet Socialist Republics (USSR), France and the United States were experimenting with satellite communications for telephone, television and weather services. Additionally, the U.S. and USSR were in a race of sorts for superiority in the area of space exploration and dominance.

In August 1962, during the Kennedy administration, the U.S. Congress passed the Communications Satellite Act, which allowed for the formation of the Communications Satellite Corporation (COMSAT). COMSAT was charged with facilitating international telecommunications as soon as possible. COMSAT, a private corporation, had the unusual task of operating under corporate law yet having to answer to a variety of governmental agencies.

INTELSAT was the result of a conference in the summer of 1964 in Washington, D.C., that was hosted by COMSAT. The United Nation's General Assembly Resolution 1721 refers to peaceful use of outer space; in deference to the resolution, 19 countries met at this International Plenipotentiary Conference on Interim Arrangements for a Global Satellite System.

A wide range of satellite communication uses, political agendas and needs was represented by the different countries at the conference. However, the one thing that everyone agreed on, in principle, was the necessity for a single global commercial system. The formation of INTELSAT was part of and subject to the conference's Interim Agreements, indicating a temporary solution with additional roles to be defined at a later date. Furthermore, it was agreed that COMSAT would manage the new international organization with the participating countries agreeing to cooperate in the mechanics of the new system. A total of 11 countries signed the INTELSAT agreement in 1964. Additionally, all participating countries agreed not to allow or encourage competing satellite communication systems to spring up in their own countries. In effect, they agreed to an American-run satellite monopoly.

Less than a year after the agreement that established INTELSAT, its first satellite was launched. Initially called Early Bird, the satellite was later referred to as the INTELSAT I to be consistent with INTELSAT's future systems .

INTELSAT I was the first successful geostationary commercial communications satellite. Previously, *passive* satellites, those that simply bounce back signals, had been tested, but their orbits and capabilities were extremely limited. Successful *active* satellites, those that truly relay or transmit to a specific point, had also been deployed, but they suffered from a lack of capabilities, too. By 1963 geostationary orbits were achieved. A geostationary orbit exists approximately 22,300 miles above the Earth's equator. Because of its distance and location, the orbit's rotation is equal to that of the Earth, and a satellite in this orbit appears to be fixed, or stationary. Satellites, while powerful, are limited to "line of sight"; that is, if a satellite can "see" you, it can transmit to you. So a satellite in a "fixed," or geostationary, orbit can continuously transmit to the area it sees. Conversely, a satellite over the Indian Ocean cannot transmit directly to Kansas because it cannot see Kansas. Most communications satellites are in a geostationary orbit. This orbit was first calculated by science-fiction writer Arthur C. Clarke in 1945 and is sometimes referred to the Clarke Belt or Clarke Orbit. One can easily imagine a ring or belt of satellites circling the Earth's waist a mere 22,300 miles out.

INTELSAT I carried 240 telephone circuits and had the capability to exchange television programming between northeastern North America and Western Europe. After INTELSAT I, the INTELSAT organization launched numerous additional satellites. The different series of satellites, each designated by a Roman numeral, represent an increase in transmission power and message capacity. Some of the satellites in a series carry an additional letter/number designation, such as INTELSAT V F1, indicating a technological "tweak" in the V series.

INTELSAT II was a series of satellites launched in 1967 over the Atlantic and Pacific oceans. INTELSAT III satellites, launched the following year, could carry 1500 telephone circuits and up to four television channels. The IV series , a total of 13 satellites launched from 1969 to 1975, included a satellite over the Indian Ocean; with this connection, world-wide satellite coverage and communication was achieved. By the early 1980's the INTELSAT V series was sent into space, and the total INTELSAT communication system consisted of 400 earth stations in 150 countries. Today the INTELSAT series I through IV and some Vs are no longer operating as the stronger, more powerful VI, VII and VIII series satellites take their places.

INTELSAT VI satellites, launched beginning in 1989, were able to carry 24,000 telephone circuits and three television channels. The VI series, for the first time, employed satellite switched - time division multiple access (SS-TDMA). This allowed for a capacity boost to 120,000 circuits, an incredible leap in power. By the early 1990's, with 15 satellites in orbit, INTELSAT provided the most extensive global telecommunications system. The INTELSAT VII series, consisting of nine satellites, started the journey into space in 1993. The VIII series satellites, launched in 1995, were able to carry 22,500 telephone circuits (with boost capacity to 112,500) and three television channels. By 1995, there were over 20 INTELSAT satellites all around the globe dedicated to a variety of services for all types of users.

From the very beginning, the United States' interest in COMSAT and INTELSAT was centered around space exploration. At the time, only the U.S. and USSR were interested in and had the means to explore outer space. (The USSR, however, was not a member of INTELSAT.) The other participating countries were either thinking about the distant future or had pressing communication needs that did not include outer space *per se*. The only way to facilitate exploration and continuous communication between the moon, the Earth and space was to have earth stations all over the globe. American businesses, seeking ancillary opportunities in space exploration, were also eager to move ahead. INTELSAT, while just an interim agency, was the stepping stone to future space exploration as well as a tool for all of the countries' telecommunication needs.

Even though more countries joined INTELSAT, the U.S. continued to be the most powerful entity represented. COMSAT, the U.S. voice, was by far the loudest and largest presence. While COMSAT generally did a good job with management of INTELSAT, both were regarded as U.S.-dominated systems, the first by definition and the second by default.

Yet even though INTELSAT, through COMSAT, was primarily serving U.S. needs, not all Americans were happy about the situation, either. American telecommunication entities, for example, were concerned that the two organizations were largely made up of scientists and lawyers and that their own industries (mainly television and broadcasting) were not given an opportunity for representation and development.

In 1968, facing criticism for the U.S. approach to and control over INTELSAT, President Lyndon B. Johnson asked that a task force be established to study the U.S. policy on telecommunications while extending the Interim Agreements, keeping COMSAT and INTELSAT in place. The next year, President Richard Nixon created a task force, the Office of Telecommunications Policy (OTP), to determine the future of INTELSAT as it affected U.S. concerns.

Finally in 1973, INTELSAT's participating countries completed negotiations and new rules, called the Definitive Agreements, were signed. The rules brought into focus and addressed the various countries' concerns and, while in some ways it was business as usual, the agreements did give the organization clear guidelines for future responsibilities and developments and specifically allowed for a more balanced, international representation in INTELSAT. Eventually COMSAT's managerial responsibility lessened to that of Management Services Contractor, allowing the day-to-day operations to be controlled by the Executive Organ, a group of representatives from various countries. However, COMSAT was still very much in the picture. In INTELSAT's 1993 annual report, the list of 132 member countries was presented along with its respective investment share. COMSAT was, by far, the largest shareholder, with 20.149553%. The next largest shareholder was the United Kingdom, at 10.989744%. Mathematically, this leaves the remaining 130 countries each with an average of .529698% share.

America's communication deregulation, which took full-force effect by 1984, opened up opportunities for companies in the fields of domestic and international satellite services. INTELSAT prepared for competition and initiated its own business system called INTELSAT International Business System (IBS). IBS was developed to provide digital end-to-end connections. It is a private-line service specifically designed for multi-national corporate business functions, such as teleconferencing, data collection and distribution and remote newspaper printing.

By the mid-1990's satellites had become a facet in all American's lives, whether they knew it or not. Many consumers had their own satellite dishes or television receive only (TVRO) devices in their backyards. Public Broadcasting Service (PBS) and National Public Radio (NPR), public television and radio respectively, were the first broadcast systems to exclusively utilize satellites to send feeds to their member stations. Commercial television and radio soon followed. Commercial broadcasters, however, not only used satellites to send programming to affiliates, but they also used satellites to gather news and programming, such as sporting events. Radio programming went through a metamorphosis of sorts, too, when programming services — songs, news and disc jockey chatter — began being delivered by satellite. Because original, locally generated radio station programming is one of a station's highest expenses, satellite programming solved many financial and low-listenership daypart (portions of the day broken down into broadcasting segments) problems for many small- and medium-market radio stations.

Additionally, all cable television networks are transmitted to cable operators by satellite. HBO, a cable movie network, was just a small service prior to 1975. In fact, its subscriber base was a mere 57,000 homes in four northeastern states until it was allowed to lease space on an RCA satellite and become the first satellite-delivered cable network. Important as communications satellites are to the radio and television industries, they are just as critical to telephony, for the vast majority of long-distance phone calls, electronic mail (E-mail) and faxes are transmitted by satellite.

While INTELSAT "owned" international satellite communications in its first decades, now it has competition from private companies as well as from other nations. During the early 1990's, plans to take INTELSAT private, to allow it more commercial freedom have been in development; predictably, negotiations have been challenging, but experts predict that a final plan may be available by the end of 1995.

The uses for satellites in communications are endless. Satellites are the figurative pavement of the information superhighway. And no one entity has helped shape space exploration, broadcast distribution or global communications like INTELSAT has.

u contributed by Michele Messenger

Interactive Services

Services based on a digital communication system capable of providing two-way communication between consumers and a variety of product, information and entertainment providers.

Televisions have historically been passive devices. They did two things: receive and display signals. All decisions regarding programming and content were made by television executives. Viewers simply watched. Interactive services, however, transform this one-way communication medium into a two-way system. Using digital technology, viewers have the ability to instantly choose what they want to watch, participate in the on-screen action, and perform a variety of everyday tasks through their television terminal.

Sending signals from homes to television programmers has been tried before, but never to the extent that current interactive designs offer. In the late 1970's, Warner-AMEX cable launched QUBE in Columbus, Ohio. QUBE was the first attempt to offer television viewers interactive ability. Opinion polls and instant audience feedback to talk shows were some of QUBE's services. The project, however, never evolved past offering very conventional programming to a limited viewer base. More recently, Interactive Networks, a California-based television service, began offering interactive entertainment programming. Subscribers have small laptop computers that exchange special FM radio signals with the network's central computer. Interactive Networks' programming enables viewers to play along with game shows or guess the outcome of sporting events. Viewers can even guess the ending of whodunit television shows.

Many cable systems today offer subscribers converters or set-top boxes (the device that sits on top of the television and converts incoming signals into ones that your television can understand) that can be used to order pay-per-view movies and other cable services. The box sends signals to the cable system's main processing center, which then responds by providing the service.

These services, however, pale in comparison to proposed interactive services a digital network will offer. That's because these systems use fiber optic and coaxial cable rather than airwaves or coaxial cable alone to transmit signals. A network using the spacious transmission pipeline of fiber optic cable can accommodate a great deal of digital information. Movies, music, and other information can all be digitized and sent through these types of cables. With the aid of computers, people can do amazing things with this information. Some of the interactive services a digital network may provide include:

Video on Demand (VOD)
This is the ability to choose movies, television shows, music videos or other film material instantly using a set-top box. Additionally, because the program is stored and sent digitally, people will be able to use VCR-like controls such as pause, rewind and stop. Today this highly anticipated feature of interactive services is being put to the test in experimental interactive networks. Video on demand's success depends upon the ability of video on demand providers to market movies as effectively as video stores as well as

on technological improvements in digital compression and storage capacity.

Home Shopping
Already a billion dollar industry in America, it is anticipated that home shopping will expand even more with interactive networks. By using a screen menu and a remote control pointer, consumers will be able to order food delivery, clothes, groceries, or any other item they want. Shoppers can browse through a selection of merchandise and even choose to view it close up or from different angles. Payments can be made via electronic banking.

Games
Interactive games will enable players to compete with each other from separate locations. New games can be ordered directly from the manufacturer through the screen. Video games will also take on a new meaning because traditional game shows, such as *The Price Is Right* or *Jeopardy*, can be produced to allow home audience members to compete alongside the studio contestants for cash and prizes.

Home Banking
Financial transactions will be conducted at home in an interactive network. Beyond monitoring account balances, users could authorize electronic fund transfers to pay bills, analyze stock performance or create a home budget. Security of financial and other personal information on an interactive network is a concern, however. Individuals who illegally tap into computer networks or databases could potentially cause chaos if security systems were not strong enough to protect private information.

Telemedicine
Practiced to some degree today with two-way video links that provide small-town doctors with access to the resources of urban medical centers, telemedicine could expand with interactive services. Consulting face-to-face with a doctor would be as easy as placing a telephone call. Home check-ups could be possible with an interactive network. With video cameras and remote health monitors such as stethoscopes and blood pressure machines hooked up to the television terminal, a doctor might be able to perform a complete physical. Of course, there are ethical considerations to take into account in this sort of system, as well as financial concerns if insurance providers do not cover such types of interactive visits.

Videophones
Because an interactive network is a two-way service, homes will have the potential to become broadcast facilities. With video systems to create and send images through the fiber optic networks, users will be able to see as well as hear each other during conversations. Also, every home could become a cable access studio with the ability to create original programming.

Distance Education
Much like telemedicine and videophones, interactive services would enable students from around the country to participate in virtual classrooms. This means that a teacher could be in Boston while communicating in real-time with his or her students elsewhere. Video link-ups would enable students to interact with the teacher and with other students.

Interactive Advertising

The interactive network presents special concerns for advertisers that have yet to be fully resolved. If viewers are not limited to watching what programmers have sent over the airwaves, it is unlikely that they will be patient enough to sit through commercials. Some experts have predicted that infomercials will become more common because they will combine entertainment with a sales pitch. People will watch them because they want to, not because they have to. Interactivity also provides advertisers the ability to offer intriguing ways to sell their products because consumers will be able to do interesting things with the information. Car buyers, for instance, could take a virtual test drive, get a listing of a car's features and shop various dealers for the best deal without ever leaving home.

Interactive Movies

New forms of entertainment could be tailor-made to meet interactive television's potential. Movies could be filmed with a multitude of variables, including different beginnings, middles and endings. A home viewer could then become part of the action by becoming a virtual movie director and choosing the route the movie takes.

Which of the preceding services will actually be offered as well as what these services will ultimately provide to consumers, has yet to be decided. There is still much to work out technologically, commercially and legally before these interactive services can be offered.

Three information industries — cable TV, telephone, and computer — have begun tests of interactive networks. The most notable is Time Warner's fiber optic-based Full Service Network (FSN) in Orlando, Florida. Concentrating on video on demand service and home shopping, FSN provides viewers with an easy-to-use menu of options. Customers use a specialized remote control to select services from an on-screen menu. Time Warner's venture, as well as other networks started by cable and telephone companies in the United States and Canada, is important for two reasons. First, experimental programs help engineers understand the technological challenges that face interactive systems. For example, unlike the converters that work with cable television today, converters dealing with digital signals will be computers designed to process incoming signals. The software that these new converter boxes will run has yet to be fully developed. Another technological challenge is to develop storage methods for the vast amount of computer information required for services like video on demand.

The second important function of pilot programs like the Full Service Network is that they help marketing experts understand how consumers are likely to use interactive services. For example, will viewers enjoy the convenience of video on demand, but be leery of home banking? Are some services mere novelties that people will soon tire of using? Companies building interactive service networks need to answer these questions in order to pinpoint the services consumers want and will use.

Beyond engineering and marketing issues, other questions that affect the future deployment of interactive services remain to be answered. These questions concern how the various telecommunication industries are regulated and how access to these new interactive services will be financed. In terms of regulation, federal restrictions on local phone and cable companies may be relaxed so these industries can offer services they are currently prohibited from delivering. Other regulatory issues include those of open access (the right for information providers to do business on interactive networks owned by other companies) and universal access (a guarantee that high-speed digital networks reach poor and rural Americans as well as the more affluent and those in metropolitan areas).

The issue of universal access also raises pressing financial concerns for both the government and information service providers. For instance, who should pay to ensure that interactive service reaches less affluent consumers? One possible solution to this question is to have information service providers pay a percentage of their total revenues into an FCC-controlled fund, which would use the money to help off-set the cost of installing and maintaining interactive services to the poor. The interactive services that this fund would subsidize would be those that are deemed important enough that everyone must have access to them regardless of their ability to pay. Such interactive services in that category might include access to libraries or to public-record materials, but not access to entertainment services such as video on demand or video games.

u contributed by Christopher LaMorte

Interactive Television

Interactive television has fascinating potential. If and when the technology comes together, viewers will be able to see (as well as pause, stop, fast forward and rewind) movies, shows and newscasts any time they want to, day or night. The newest shopping malls will no longer be opening across town, but debuting on the living room TV. Buying and selling groceries, clothing, gifts, major appliances, cars, even homes, will be possible through new two-way technology that combines television, telephones and computers. And that's just the beginning.

Major corporations are already staking their claims on the future potential of interactive television by committing billions of dollars to research and development and the upgrading of existing communication delivery systems. As a result, interactive television, in one form or another, looks to be in everyone's future.

An Intriguing Concept Still Struggling for Consensus

At its most basic, interactive television is part television, part computer and part telephone. The relative importance of each varies according to with whom you're talking at any given moment.

If it's a broadcast network or cable TV executive, television programming (some eventually interactive) is the driving force of this burgeoning industry. If it's a telephone executive, the cutting-edge technologies of these government-sanctioned monopolies (or common carriers as they are known) is what will make interactive TV a reality. And, if it's a computer hardware or software executive, the almighty microchip, and its ever increasing capacity, is the basic building block of future television.

Interestingly, each is right and somewhat wrong. That's because interactive television is, by its very nature, a technology of convergence among television, telephone and computer. The good news is that American homes, in fairly substantial percentages, are already saturated with some of the basic technological building blocks of interactive TV (telephones 93.7 percent; televisions 98.3 percent; cable television 63.4 percent). The bad news is that no one has come up with a universal system combining all the elements in an easy-to-use, efficient, economical system that will serve millions of homes, all at the same time.

As the debate on interactive television has intensified over the past 10 to 15 years and as the technology has progressed from the purely hypothetical to actual prototype systems, the predictions about what interactive TV will be able to accomplish have become more grandiose as well. Yet, given the advances in information and communication technologies that have taken place in the last decade, interactive experts may be more on the mark than first thought.

The key component or service mentioned whenever interactive television is discussed is video on demand. While it sounds simple enough, the ability to provide this service to tens of thousands of households at the same time is enormously complex. Not only must the service provider be able to offer hundreds of video titles at any given time, but the consumer also expects to have the ability to control the video. The phone rings, the baby cries, the stomach growls. The viewer has to have the ability to stop, start or go back and review crucial scenes. Not only does the interactive system have to allow individual control, but it must be able to compete with $3 video rentals, as well.

Other interactive services touted by industry observers involved in this multi-billion dollar gamble include: news-, financial- and sports-on-demand; home shopping (clothing, cars, major appliances, jewelry, groceries, etc.); medical check-up services; music on demand; and home banking and bill paying services. Consumers may also be able to use their interactive televisions to monitor and control their home energy management systems; answer the telephone and record messages; or tap into on-line services and download vast amounts of information (data, voice and video) for personal, professional or business purposes all at blinding speeds.

In one interactive test conducted by Jones Intercable, one of the nation's top cable operators, the line between television and computer is being all but eliminated. Although limited, this test illustrates the huge jump in computing power that interactive systems will be dealing with in the future.

Jones is providing access to the Internet over cable lines to two schools, a public library and two homes in Virginia. This unique link boasts a data rate of 500 kilobits per second. That represents the ability to transmit and deliver 57 pages of text per second. Compare that to the common 14.4-bps modem (which delivers only 1.6 pages per second) or the high-speed 56 kilobit Internet connection (roughly five or six pages delivered each second) some businesses and schools enjoy today.

To say such speeds or the financial stakes to develop them are high is an understatement.

Depending on who is talking, the revenues to be generated, from everyday video on demand to a host of specialized interactive shopping malls, range from merely fantastic to astronomical. One forecast of a $1 trillion market within a decade is not all that hard to imagine given that there are currently more than 95 million television households in the United States (60 million of which are already wired for cable).

Yet, when it comes to figuring out how all these services will be delivered, there's still a big question mark. Major corporations are merging, going their own way or cooperating with long-standing foes, and sometimes doing all three, depending on which aspect they're developing. Untold billions of dollars are being spent trying to perfect the technology that will crack open interactive TV worldwide.

Interactive Technology Takes Shape

The future of interactive television centers around two basic technological developments: fiber optics and digital television. One provides a superior pathway of thread-like pure glass, which offers little or no resistance, along which information-laden laser beams can travel. The other allows for vast amounts of information, whether it's raw data, video or audio signals, to be compressed and relayed, again and again with essentially no distortion or discernible degradation.

Despite the existence of these technologies and their expanding use, interactive providers still have their work cut out for them. Their basic challenge revolves around developing powerful hardware with massive storage capacity (huge disk drives and file servers) that operate with incredibly flexible software to handle the minute-by-minute demands of thousands of different customers.

One provider, currently conducting an interactive test in Florida, thought the terabyte file server it had developed (which holds the equivalent of one million floppy disks) would be more than enough to store the hundreds of digitized movies the company wanted to offer in its video on demand test service. But the company has already discovered it's going to need a server that's twice that size just for the test.

Consumers too will have their own demands of any interactive service and will need some very special equipment to interact with their TV. The device they'll be using the most is a new version of the set-top box, or converter, that currently ushers cable programming into many homes across the United States. The reincarnated set-top box will be far more powerful and infinitely more sophisticated than the ones that currently dot America's living room landscape.

Not only will these new set-top boxes have to process vast amounts of compressed, digitized signals, but they'll also have to handle all the requests and commands that will be an integral part of the interactive exchange, as well as track and relay information on all billable transactions. (Some of the first interactive set-top box prototypes already possess as much as five times the computing power of the most powerful PCs presently available.)

These new set-top boxes will have to meet three essential criteria to be successful. First and foremost, they have to be user-friendly to the vast majority of the consuming public. Given the fact that many viewers still have a hard time programming their VCRs, that's no small feat. Secondly, the set-top boxes have to be affordable, whether as part of an ongoing lease agreement or through outright ownership. Observers predict acceptable ownership costs to be no more than $300 total. And, finally, but no less importantly, these set-top boxes have to be compatible with any and all available providers in a given area. That includes cable TV, telephone, regular broadcast or direct broadcast satellite (DBS) systems.

The Battle for the Interactive Breakthrough

With $1 trillion market projections dancing in their heads, American communication and information leaders are hard put to resist the lure that interactive television presents. The race to develop a working model of an interactive system has brought two formidable adversaries eye-to-eye over the future interactive television will take.

In one corner are America's cable television providers. In another corner are the nation's Baby Bells, or regional Bell operating companies (RBOCs). Each has particular technologies, existing infrastructure and distinctive strengths that lend themselves to developing a functional interactive television system. They also have discernible weaknesses that their opponents aren't shy about exploiting. And, to top it off, they're both trying to break into each other's core businesses.

Meanwhile, circling the ring are some very powerful interactive groupies. Some, like Intel and Scientific-Atlanta (S-A), are in position to reap enormous rewards no matter what interactive configuration is declared the winner. Others, like software heavyweights

Silicon Graphics and Microsoft, have already chosen sides or are planning to step into the ring themselves with their own knockout solution to the interactive puzzle.

What follows is a brief summary of the current situation from both the cable and telephony point of view. Keep in mind, the situation for either or both combatants could change drastically at a moment's notice with another technological breakthrough, an unexpected merger of either friends or foes, or a favorable ruling from Washington on any number of critical issues.

The Cable Connection to the Future

Television savvy and programming expertise make the country's largest cable systems natural players in the future of interactive television. In addition, their experience in providing a wide variety of programming options will also be a valuable component in any interactive future.

Due to improvements in amplifier technology, the ability of cable systems to carry more channels increased from 20 channels in the 1960's to more than 100 just one decade later. Signal digitalization will further increase that carrying capacity. Yet, it's important to remember that, despite the predictions of a 500-channel future (through digital compression, fiber optics and improved coaxial cable), it has yet to be proved that there is a real consumer demand to surf through that many channels.

The cable industry's abilities to participate in an interactive system are backed up by a hard-driving desire to develop such a system as soon as possible. Major cable companies — Tele-Communications, Inc. (TCI), Time Warner, Cox Communications and Jones Intercable — have committed themselves to spending billions of dollars to develop various aspects of an interactive television system.

A wide variety of experiments are being conducted around the country, by cable companies and telephone companies individually, as well as by some strategic partnerships of both. By far the most ambitious and scrutinized test to date is Time Warner's Full Service Network (FSN) test in northern Florida. The $5 billion, five-year test brings together American Telephone & Telegraph (AT&T) switching technology to route data; Silicon Graphics' operating software and storage hardware; and Scientific-Atlanta's converter (set-top box) technology to bring the interactive network into selected homes in Orlando, Florida.

Originally scheduled to begin in April 1994 with 4,000 subscribers, the FSN experiment has proven to be an abject lesson in the frustrations, complications and delays of interactive research and development. FSN was finally introduced in December 1994 with barely a half-a-dozen homes on-line. Yet, despite this humbling experience in interactive development, the FSN test has made some important strides in basic interactive technology.

Although limited in scope, FSN does offer video on demand, with fully functioning viewer control of the video, including pause, stop, and rewind/review functions. Viewers can even halt their movie videos to take a stroll through a computer-generated shopping mall or visit a video-game area to play an interactive game of cards with their neighbors.

The trick, as they say, will be not only Time Warner's ability to expand the roster of interactive services for the first half-dozen subscribers, but the basic service itself to the thousands of homes originally envisioned in the test as well. Only then can the true economics of the system even begin to be proved or disproved.

RBOCs Looking for a Piece of the Action

The genesis of the battle for interactive television between telephone and cable companies was the breakup of AT&T in 1984. As a result of the consent decree that dismantled AT&T, the seven RBOCs continued operating as regulated monopolies specializing in local telephone service. However, the decree also stipulated they could not manufacture telephone equipment, provide long-distance service or provide other information services.

The RBOCs were never happy with the restrictions and moved to have them lifted legislatively and judicially. The companies were also fighting a ban on telephone-cable company cross ownership that had been enacted by Congress with its 1984 cable deregulation act.

The mood in Washington began to change during the Reagan and Bush administrations, when officials began advocating the position that the RBOCs be allowed to provide cable services on a common carrier basis. In June 1992, the Federal Communications Commission (FCC) adopted its video dial tone rules that would allow the RBOCs to provide video programs over phone lines. The FCC also recommended that the telephony-cable cross-ownership ban be lifted as well.

Congress failed to follow that recommendation, however, and one RBOC, Bell Atlantic, went to court to have the ban struck down through its Washington subsidiary, C&P Telephone Company. The company had applied for and was refused permission to operate a cable system in Alexandria, Virginia. C&P Telephone Company and corporate parent Bell Atlantic took the case to court, alleging the ban on cable operations violated the First Amendment. In August 1993 the court agreed. The government decided to appeal, and other RBOCs decided to join the battle with similar suits around the country.

By the end of 1994, four other RBOCs — Ameritech, Bell South, NYNEX and U S WEST — had received similar rulings in their suits. Then, a short time later, the federal appeals court upheld the original Bell Atlantic ruling. The anti-competitive wall between the RBOCs and the cable industry was finally demolished. But, the battle was far from over.

While the RBOCs have filed more than two dozen requests with the FCC to establish video dial tone service, they still have to meet strict standards. They must establish a video network that is both large enough to handle multiple programmers and able to be expanded later. They cannot lease all or substantial portions of their carrying capacity to an individual anchor programmer. Most importantly, and particularly irritating to the RBOCs, they must file a tariff detailing how they expect to recover development and construction costs through video revenues.

This last point is a major area of contention between the cable industry and the RBOCs. Cable providers believe that the RBOCs' deep financial pockets and the steady cash flow generated by government-regulated rates establish an unfair competitive advantage in the RBOCs' favor. In effect, cable operators and consumer watchdog groups believe the telephone companies will use their phone service revenues and possible rate hikes to subsidize their foray into video services. Nevertheless, the existing rules will compel the telephone companies to endure complicated, and most likely combative, rate hearings before they're allowed to begin construction of their video dial tone systems.

In a turnabout that's on the same plane as the all's fair in love and war standard, the cable companies have begun an effort to secure their right to provide telephone service. In 1994, the U.S. House of Representatives passed legislation that gave the RBOCs the right to provide video and long distance services. The Senate then tacked on a tit-for-tat provision that would have granted cable companies the right to offer local telephone services. Vociferous lobbying by three RBOCs killed the legislation in its tracks.

The halt in legislation has not slowed down the cable industry's effort to, in its words, level the playing field for the coming interactive age of telecommunications. In late 1994, Time Warner Cable submitted a request to the Ohio Public Utilities Commission seeking approval to provide residential and business phone service throughout the state. Almost at the same time, three of cable's major players — TCI, Comcast Corporation and Cox Enterprises — revealed their tentative agreement with long distance carrier Sprint to create a new joint venture designed to compete with local telephone companies.

Recruiting Allies for the Coming Battles

Despite the ongoing battles in the courts and the halls of Congress, both the cable companies and the RBOCs are proceeding with ambitious research and development efforts to establish working interactive television systems. In some cases, they've even joined forces to design and conduct tests in specific markets.

Long-term mergers between cable concerns and telephone companies have been proposed, only to be scuttled later. Reasons for their demise have been officially attributed to regulatory problems. Industry insiders, though, have suggested it has more to do with trying to merge two different types of companies and a clash of personalities between their single-minded executives.

While dissolved mergers with cable companies in the past don't preclude long-term agreements in the future, the RBOCs have continued to explore other alliances that could bolster their position in interactive television. They definitely have the technological expertise and the money to develop interactive systems. What they really lack is the ability to produce programming. And, while broadcast networks have expressed their support of the RBOCs' entry into the market, they won't be able to supply all the programming a telephone interactive network would need.

The RBOCs have set their sights on addressing that need. In the fall of 1994, Ameritech, BellSouth and SBC Communications (formerly Southwestern Bell) reached agreement on a video programming deal with the Walt Disney Company. A few months later, Bell Atlantic, NYNEX and Pacific Telesis agreed to form a new media company to produce programming. The key adviser to the new company is Michael Ovitz, head of the Creative Artists Agency (CAA) and a noted Hollywood dealmaker.

In response, the cable industry has undergone its own convergence of power. Major buyouts and mergers within the industry, dubbed a clustering strategy, have set the stage for head-to-head battles with RBOCs on their own turf. This merging strategy between cable companies in adjacent or overlapping territories has put companies like TCI, Time Warner and Cox Communications on the front lines of the looming interactive struggle.

And Don't Forget Broadcast Television...

While the RBOCs and the cable companies are center stage in the current interactive show and tell, broadcast television may yet have its chance to be an interactive headliner. Much of broadcast television's interactive star power rests on companies that can exploit and develop a set of frequencies set aside by the FCC for interactive television applications.

Dubbed Interactive Video Data Services (IVDS) by the FCC, these new services would, in theory, provide two-way communication (of data, voice and video) using over-the-air frequencies instead of coaxial cable or fiber optic wires. The FCC laid the groundwork for IVDS by dividing the country into 306 markets or service areas. Each area will be served by two IVDS licensees.

Those who win FCC license approval must meet certain basic requirements. A key stipulation is that each licensee must build a system that serves at least 10 percent of the designated market within a year of being approved. This relatively quick startup turnaround is being hampered by equipment shortages.

So far, two companies have developed IVDS equipment. One company is EON, based in Reston, Virginia, and the other is Radio Telecom & Technology in Riverside, California. The equipment itself must go through a two-month certification process at the FCC as well. This may delay some of the IVDS operations initially approved.

In March 1994, 18 IVDS licenses covering nine markets were awarded in an FCC lottery. Later that summer, licenses in the remaining 297 markets were auctioned off by the FCC. Because of equipment delays, a number of the bidders and IVDS license-holders have technically defaulted on their IVDS bids and licenses. Once these bureaucratic glitches have been straightened out, it will be interesting to see how effective and competitive over-the-air interactive TV will be against the massive cable and telephone efforts.

The Battle Has Only Just Begun

The controversies created by the corporate clashes, legislative showdowns and regulatory ambushes are just preliminary skirmishes. The big battles have yet to be fought. The war for interactive supremacy won't really be waged until everyone has agreed upon the weapons, that is, the technologies that make a viable interactive system.

Those technologies, in turn, will determine the ultimate showdown...with the consumer. Only after viewers are satisfied with the products they're offered (and a good deal of their satisfaction will center on how much they have to pay for them), will the real clash for the hearts and televisions of America begin.

The excitement is in knowing that technological breakthroughs could happen at any time. When they do suddenly occur, and they will, it will be fascinating to see who's left standing when the interactive dust settles.

u contributed by Michael C. Lafferty

Internet

A global computer network that connects thousands of networks together, allowing them to exchange files, send messages, download graphics and text, and share other resources. There are over 30 million people connected to the Internet worldwide.

In the late 1960's, a group of scientists were working on a project for the U. S. Department of Defense. To finish their work, they needed to share reference materials and exchange notes frequently. Unfortunately, the scientists were at different research sites across the country. They needed to come up with a quick and efficient way to send information back and forth. The best way turned out to be electronic.

They created a computer network unlike any other. Called the Advanced Research Projects Agency Network (ARPANET), it broke information into small chunks known as packets. The packets could be sent through the network independently until they reached their final destination. Then they could be reunited and read. This process is called packet switching. ARPANET officially went on-line January 2, 1969.

In 1975, control of ARPANET was given to the U. S. Defense Communication Agency. Traffic increased rapidly, and ARPANET was split into two separate networks: MILNET was used by military personnel and ARPANET was used by civilian military contractors. Since both networks could communicate with each other, they became known as the Internet.

Then in the mid-1980's, a third computer network connected to the system. The Because It's Time Network (BITNET) was designed for universities and other educational institutions. The increased traffic caused the Internet to slow down considerably, and its founders decided they needed help upgrading the system.

The National Science Foundation (NSF) stepped in to solve the problem. This government agency, whose function is to promote science and its studies, had several supercomputers at different sites across the country. The agency used its extra space to give the Internet a boost. Connecting these sites to each other made the supercomputers more efficient. Scientists, researchers, and engineers could access the supercomputers' vast resources from their own laboratories and institutions.

The supercomputers were connected by a set of high-speed networks. Together with microwaves, lasers, satellites, fiber optics, and high capacity telephone links, they formed the backbone of the Internet.

The NSF officially took over the Internet in 1990. It was then opened to the general public. Business and residential users now connect to the Internet by commercial service providers. These groups, like Netcom and UUNet, obtain space on the network from the NSF.

Packets of information go through the Internet in a set way. First the information is sent though a local computer that is connected by a modem and a phone line or linked directly through a campus network. This computer may be known as a host, a resource available to other local computers.

The information will go through a series of connections before reaching its final destination. A repeater will refresh the packet, allowing it to go further. Hubs connect groups of computers together, allowing them to take turns communicating. Bridges link two distant local area networks (LANs). Gateways translate data between one network type and another.

If information must be sent a great distance, it may go through a device known as a router. This is an intelligent bridge that reads the address of the packet, and then decides the best way to send the packet to its final destination based on the amount of traffic on the network.

If the document needs to go across the country or around the world, the router sends the packet to a Network Access Point (NAP). The packet is then shot along the backbone to its final destination.

For Internet communications to be routed effectively, the system has been designed to follow a set of rules known as protocols. There are a number of important protocols, but one is the core of the Internet. Known as the Transmission Control Protocol and Internet Protocol (TCP/IP), this set of rules is responsible for breaking the data into packets and putting it back together at the final destination.

Telnet, another type of Internet protocol, allows a user's computer to connect directly with an outside computer host. The other system can be across town or around the world. The user's computer acts as a terminal for the information on the other system. It can run programs, open files, and use connected outside peripherals, such as printers, CD-ROM drives, and video cameras. Sometimes users need a password or an account number to log on a system using Telnet.

To download information through the Internet, users must follow File Transfer Protocol (FTP). It is a simple way to move files across the network. Users can go directly onto other systems with FTP or use robotlike programs called Gophers to find files. FTP software creates a connection between the user's computer and the host's computer. The user can copy files into his or her own system or send files to the host's setup. Users cannot run any programs or open any files without logging off and re-signing on using Telnet.

Electronic mail, or E-mail, sends messages back and forth between computers that are electronically connected. The user types a message onto a computer while signed on to the Internet or an on-line service. The message may include text, graphics, files, or multimedia. The user then tells the system where to send the message. After that, the message is sent over the Internet until it reaches its final destination.

Since the Internet is a series of networks connected together, the E-mail address must specify to which network the data is supposed to go. The network's address is known as the Domain Name System (DNS). Each network is responsible for maintaining its own addresses and mailing lists. A typical address will contain the name of the individual to receive the message, the network he/she is on, and the type of network it is (government, commercial, education, etc.). For example, an E-mail for commercial service America Online's founder Steve Case would look like stevcase@aol.com.

The Internet was started as a way to exchange information. It is no wonder then that so many protocols on the network were designed to make this task easier. For example, mailing lists are databases of Internet users who want to discuss a particular topic, such as child care or the treatment of depression. Each participant subscribes to the list and receives messages from other members. The list is only available to other subscribers, which helps keep topics relevant to the list's subject. When a subscriber posts a message to the mailing list, it goes through a mail reflector, or listserve. These devices make sure that each member of the group receives the postings and they help facilitate subscriptions and changes.

Usenet groups also help provide information to interested participants. The groups are broken down into more than 20 major hierarchies or areas of particular interest. They include, among others, sociology, biology, alternative topics, recreation, business, and miscellaneous. The hierarchies are broken down even further into specific subjects of interest. A group on Generation X topics becomes alt.generation.x, for instance. While there are over 6,000 newsgroups, the administrator of each network decides which will be available to users.

The World Wide Web (WWW) is the newest addition to the Internet protocol system. Until its development in 1993, all information sent through the Internet was text-based. The WWW allowed graphics, sound bytes, and video to be part of accessible files. For the first time in its history, multimedia could be found on the Internet. Information is accessed through the Web today by creating hypermedia links. These links allow the user to "jump" from one Internet site to another without logging off and re-signing on. Users are in complete control and can decide how much time they want to spend in a particular area. WWW sites connect with newsgroups, Gophers, E-Mail resources, and other servers.

There are several different ways to connect a user's computer to the Internet. The fastest and simplest way is to set up a direct connection between a computer and the backbone of the Internet. Unfortunately, this type of connection is very expensive. Users who select this approach are usually large companies and educational institutions.

Shell accounts make up the bulk of personal users. They work by turning the local computer into a dumb terminal. A user signs onto an outside network through telephone lines. The user then decides what area of the Internet he/she wishes to look at by typing in specific network instructions. The host network then finds the requested site and transmits the captured data to the user. The user can view the data immediately or save it for later use. No Internet software is actually stored or used on the local computer. Users only have access to the resources the network administrator allows them to view.

Two new types of connections have recently been introduced, partially due to the needs of the WWW. Serial Line Internet Protocol (SLIP) and Point to Point Protocol (PPP) allow users to sign directly onto the Internet using high speed modems. The user's system is directly connected to the Internet by way of an Internet carrier. Users have complete access to all the resources of the Internet and can decided what parts of the network they wish to view. The main difference between the two is PPP's ability to watch the information sent to the user’s computer. If something is transmitted unclearly, the PPP connection will request that it be resent. The SLIP connection is slightly faster but does not recognize transmission mistakes. Users need a SLIP or PPP connection to download multimedia programs or to connect with the WWW.

Network operators are looking for new services to put on the Internet. One day in the near future, users might be able to use the Internet for everything from downloading movies on demand to paying their bills electronically. Multimedia applications are already a big part of the WWW and should continue to grow as transmission speeds accelerate.

But security is still a big problem for the Internet. Because users can sign onto sites from all over the network, it’s hard to tell who is using the system. Some individuals have broken into host computers and stolen protected information. Host systems try to protect themselves by creating firewalls, or buffers, between protected and publicly available files. Many Internet users also encrypt, or code, their documents. However, most Internet security analysts believe that true security is an impossible goal, due to the open systems nature of the Internet.

Computer viruses pose another security problem. Computer viruses are programs that attack computers in the same way viruses attack human beings. They enter the system at a vulnerable site and proceed to damage its data, programs, and operating systems. These destructive programs can quickly spread through any network, but are more likely to cause wide-spread damage through the Internet.

The Internet is a community unlike any other. There is no one body that governs its use or infrastructure. Instead, each network on the Internet works with every other to make sure the system continues to operate. Each network pays for its own computers and chips in to pay for the infrastructure of the Internet.

Users of the Internet come from all over the globe. The U.S. government is working with others worldwide to make sure that the Internet remains available to anyone who wants to use it. While the majority of subscribers are from the United States, the demographics of the Internet are changing rapidly. Over 30 million users worldwide are connected to the network today. The Internet will no doubt remain an important part of global communication.

u contributed by Leigh Ann Shevchik

Jobs, Steven Paul (1955 –)

American computer executive and founder of NeXT Computer, Inc.; primarily known for co-founding industry giant Apple Computer, Inc. with partners Stephen Wozniak and Armas "Mike" Markkula.

Steven was born in 1955 and adopted shortly afterward by Paul and Clara Jobs of Mountain View, California in the Silicon Valley. The family moved to another city in the Valley, Los Altos, when Jobs was in junior high. During this time, he became friends with a high school student named Stephen Wozniak who shared Jobs's interest in electronics. Their friendship and mutual interests would later lead the "two Steves" to make a fortune.

While a Homestead High School student, Jobs also attended lectures after school at Hewlett-Packard (H-P) in nearby Palo Alto. After meeting H-P's president, Jobs landed a summer job there working on a computer assembly line. Also while attending Homestead High, he was introduced to an underground movement called "phone phreaking" by Steve Wozniak, who was then a student at the University of California at Berkeley. This led them to begin making illegal "blue boxes" that made free long-distance calls by simulating the necessary telephone tones. Jobs obtained the parts and Wozniak built the boxes, which they sold for $150 each to several hundred buyers who were mainly college students.

After graduating from high school in 1972, Jobs went to the private Reed College in Portland, Oregon, for one semester. He eventually returned home and worked for video game manufacturer Atari in 1974 as a game designer. Atari sent him to Germany to correct a problem with some games there, and he went on to India afterward to seek spiritual enlightenment with a Reed College friend. Near the end of 1974, Jobs returned home and worked off and on for Atari. During this time, Jobs and his friend Steve Wozniak collaborated on a video game for Atari called *Breakout*. Both of them were also involved in the Home-brew Computer Club in Palo Alto, comprised of about 1,500 young computer enthusiasts.

Although Wozniak was employed at Hewlett-Packard, in his spare time he was working on an innovative computer circuit board of his own design. Jobs saw the potential in it and convinced his friend to try to sell it to computer hobbyists. So the two Steves joined forces and began building the circuit board in earnest in the garage of Jobs's supportive parents. Although both were computer buffs, Wozniak was the technical expert and Jobs the marketing visionary.

Jobs approached Atari's founder Nolan Bushnell about financing for their project, but Bushnell wasn't interested. The two Steves finally financed the project by selling Jobs's Volkswagen van and Wozniak's calculator. They called their new machine the Apple Computer and in 1976 sold 600 units at $666.66 each. Despite its humble beginnings in a garage, the Apple became the genesis of a huge new industry in personal computing.

Jobs, Wozniak and retired electronics engineer "Mike" Markkula (their new partner) incorporated the company in January 1977, calling it Apple Computer, Inc. That same year, the company successfully launched the Apple II PC, the first computer to be sold in preassembled form and the first commercially successful computer for personal use (earning $2.7 million the first year and $200 million by 1980). Jobs's contribution to the Apple II was its then-innovative beige plastic casing. He also worked with a public relations agency to create the company's logo: a rainbow apple with a bite taken out of it. In 1979, Apple's president Michael Scott reorganized the company into divisions, and Jobs was given no defined role besides titular Chairman of the Board.

A true American success story, Apple Computer, Inc. dominated the burgeoning personal computing market. When it went public in 1980, Jobs was Apple's largest stockholder with 15% of the shares, valued at $256.4 million. By 1983, his holdings were worth $437 million.

Apple introduced the Lisa, a personal computer with a hand-held mouse for business use in 1983, and the Apple III reached sales of $100 million. The company launched the Macintosh PC for general use in 1984. Although not immediately successful, the Mac has an installed base today of over 10 million units.

But the mid-1980's were turbulent for Apple as external market pressures and internal squabbling took their toll. President and CEO John Sculley reorganized the company in 1985, diminishing Jobs's role once again. So Jobs decided to start a new computer-oriented company while retaining his role as Apple's Chairman. When he proposed to take some of Apple's key employees, the board of directors essentially fired Jobs as Chairman and filed suit against him. The lawsuit was eventually settled out of court, but Jobs's tenure at Apple was finished.

Jobs did go on to found NeXT Computer, Inc., originally a computer company for higher education, with backers such as Stanford University and financier H. Ross Perot. In 1988, NeXT launched its workstation computer (the first to use erasable optical disks as the primary mass storage device) and licensed its graphical user interface system to IBM. In 1993, NeXT sold its hardware business to Canon to concentrate on its NeXT step software.

Although still involved in the computer industry, Steven Jobs will probably always be remembered as one of the "two Steves" who founded a personal computer company called Apple in a garage and helped quickly take it to a leadership position, changing the face of computers forever and making a fortune in the process.

u contributed by Kay S. Volkema

Johnson, Robert L. (1947 -   )

African-American business entrepreneur, he developed the nation's first and only television network showcasing quality black programming. Johnson is currently President and Chief Executive Officer of Black Entertainment Television (BET).

Robert L. Johnson is an innovator and a pioneer. A graduate of the University of Illinois with a master's degree in Public Affairs from the Woodrow Wilson School of Public and International Affairs at Princeton University, Johnson has held positions at the Washington Urban League and the Corporation for Public Broadcasting. A former press secretary to District of Columbia congressional delegate Walter E. Fauntroy, he also served as Vice President of Government Relations for the National Cable Television Association (NCTA) from 1976 to 1979.

As the President and Chief Executive Officer of Black Entertainment Television, Johnson oversees a $74 million media and communications enterprise. Although started as a part-time service in 1980, today BET reaches more than 40 million cable households in 2,500 markets. In 1991, BET made an initial public offering to become the first Black-owned company to be traded on the New York Stock Exchange. Tele-Communications, Inc. (TCI) and Home Box Office (HBO) are major investors in BET.

Johnson's vision for quality programming that reflects the needs, interests and diverse lifestyles of Black America is now a reality, offering a unique selection of urban contemporary programming that includes music videos, sports, family situation comedies, concerts, specials, talk shows, children's programs, news and information.

BET also reflects the African-American culture through a variety of media properties, some of which are Action Pay-Per View, *YSB (Young Sisters & Brothers)* magazine and *Emerge* magazine. BET has also entered into joint ventures to fund, produce and distribute Black-oriented entertainment: United Image Entertainment, a joint production venture with actor/producer Tim Reid based in Los Angeles; BET Film Productions, a joint partnership with Encore and LIVE Entertainment; and BET Pictures, a joint venture with Blockbuster Entertainment Corporation.

Johnson finds time to serve the public and the industry with a variety of board positions: Hilton Hotels Corporation, Liberty Communications, Cable Television Advertising Bureau, National Cable Television Association's Academy of Cable Programming, American Film Institute, Federal City Council, National Park Foundation, and the Advertising Council.

All of Johnson's important and insightful efforts to provide a national platform showcasing the creativity and diversity of the Black entertainment industry have not gone unnoticed. He has received the Communicator's Award from Black Radio Exclusive, the CEBA Award from the World Institute of Black Communications, Inc., Princeton University's Distinguished Alumni Award, NAACP's Image Award, and the NCTA's President's Award.

A resident of Washington, D.C., Johnson and his wife, Sheila, have two children.

u contributed by Diana L. Hollenbeck

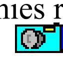
Jones Intercable, Inc.

Jones Intercable, Inc. is one of the ten largest cable television operators in the United States. Headquartered in Englewood, Colorado, it is one of many companies under the leadership of Chairman and Chief Executive Officer (CEO) Glenn R. Jones. It is the only publicly held subsidiary of the privately owned parent company, Jones International, Inc., which was founded in 1969. Jones Intercable is perhaps best known throughout the country for early adoption of high technology systems and its revolutionary approach to higher education through distribution of its affiliate, Mind Extension University (ME/U).

In 1967, following an unsuccessful bid in which he ran for the U.S. Congress in Colorado's First Congressional District in Denver, cable television attorney Glenn R. Jones took a different path in cable television and launched one of the most enterprising multiple system cable television operating companies (MSOs) in the country. After negotiating the price of $12,000 to purchase his first cable system in Georgetown, Colorado (which had a total of 150 subscribers at the time), Jones convinced the owners of the system to accept a down payment of $1,000 cash. Truly resourceful, Jones borrowed $400 on his Volkswagen and raised the additional funds by collecting payments from subscribers who had delinquent accounts.

Just one month later, Jones purchased his second system in a small neighboring community and convinced the former owner to stay on and work with him as a technician for the company. Together, the two of them strung cable on telephone poles for new subscribers. This was a brave new world for an attorney. But Glenn Jones knew then that a large part of the communications, entertainment and educational future of the United States and, indeed, the world was going to be linked to cable television technology. He was so convinced of this fact that he calculated the cost to install cable throughout the country at that time at approximately $10 billion. The hurdle, however, was raising that tremendous amount of cash.

Shortly thereafter, he expanded his young company by buying another cable system in California. It was during this time that Jones devised the popular financial structure now known as public limited partnerships as a means of raising capital for additional cable acquisitions. His notion that entrepreneurs would want to invest in the growing cable television industry and entrust the management of the business to his company was well received. In fact, because of the success of this concept, Glenn Jones founded Jones Intercable in 1970; currently, it both owns and manages 41 cable systems in 20 states.

In succeeding years, Jones established dozens of other companies related to the telecommunications industry. One was Jones Spacelink, Ltd.  , a second cable television operating company, which was acquired by Jones Intercable in 1994.

Other companies include Jones Education Networks, which comprises two 24-hour cable channels — one devoted to delivering educational programming and another focusing on computers for computer users of all levels. An earnest advocate of higher learning, Glenn Jones founded Mind Extension University (ME/U) in 1987, and is regarded as a pioneer in promoting the concept of distance education through the college-credit and intellectual enrichment classes offered on ME/U. He believes that it is a viable and growing alternative to traditional, campus-based study. Today, ME/U is available in 26 million cable households throughout the country. It provides accredited classes for earning degrees in a variety of disciplines from numerous colleges and universities.

A recent article in *The Denver Post* reported that ME/U has more than 5,000 students in all 50 states working at any given time on earning a degree. In addition, those taking non-credit courses increase the total participating student population to more than 40,000. The same article featured a young, married student from Miami who was the first ME/U graduate from Denver's well-known Regis University in May 1995. Through ME/U, Pablo Lucas, a full-time employee of the Miami division of Hypen Latin America Inc., earned his BA and MBA in a year and a half. Lucas, who had already received an associate degree, noted that this was the same amount of time it would have taken him to complete a BA in computer engineering on campus in Florida. In 1994, ME/U expanded its service internationally to Great Britain, Brazil, the Caribbean Basin and Germany. Current plans call for Jones Education Networks to launch two new programming channels in the near future that will feature courses in foreign languages and health care.

The other innovative programming service launched by Jones Education Networks is Jones Computer Network (JCN), which features 12 hours of daily programming directed to computer users at every level of skill. Jones has also established Jones Interactive, Inc. (JDC), a producer of digital publishing and interactive media products, including this encyclopedia--a CD-ROM featuring the most up-to-date information available on telecommunications and the information superhighway. In December 1995, JDC also released a CD-ROM titled *Charlton Heston's Voyage Through the Bible.* Recorded almost entirely on location in Beth She'an, Israel, Heston takes the user on a remarkable journey through the world of the Bible, from Egypt to Damascus and Galilee to the Desert of Sinai, recounting some of the most powerful stories from the Bible.

In 1989, Jones Entertainment Group, Ltd. (JEG) was established as an independent production company committed to creating high quality film and television features with wide appeal. It has offices in both Denver and Los Angeles. Since its inception, Jones Entertainment Group has produced such notable feature length films as *The Little Kidnappers*, starring Charlton Heston, which was made exclusively for The Disney Channel and the Canadian Broadcasting Corporation; *The Story Lady*, produced in conjunction with NBC Productions, and broadcast as an NBC Holiday Special movie in December 1991; and *Charlton Heston Presents the Bible,* a four-hour documentary/performing arts special produced for cable television's Arts & Entertainment Network (A&E). It originally aired on A&E in December 1992.

One of the group's most recent ventures, *The Whipping Boy,* was produced for The Disney Channel and made its debut in 1994. It received a Cable ACE award in 1995 for Best Children's Programming Special. The film had its theatrical release in Germany and Australia in 1995. JEG's second theatrical venture was *The Secret of Roan Inish.* Written and directed by John Sayles, it was shot on location in Ireland and received high acclaim when it opened in New York and Los Angeles in 1995.

The list of other companies founded by Glenn Jones is substantial. Another example is Jones Satellite Networks, Inc., the nation's largest provider of 24-hour music programming formats serving nearly 1,000 radio station affiliates in 49 states, the British

Virgin Islands and Bermuda. In addition, SUPERAUDIO Cable Radio Service is a joint venture between two major audio services, Galactic Radio Partners, Inc., a subsidiary of Jones International, Ltd. and Tempo Sound, a subsidiary of DMX, Inc.

With future plans for increased domestic and international growth, Jones Intercable finalized an agreement in December 1994 with Bell Canada International (BCI) headquartered in Montreal, Quebec. This agreement called for BCI to invest $400 million to purchase 30 percent of Jones Intercable. This agreement also gave Jones a 14 percent ownership in Bell Cablemedia PLC, Britain's third largest cable and telephone company, which has already begun delivering video telephony services in the markets it serves in the United Kingdom. In addition to providing added resources for the purchase of more cable systems, the BCI alliance gives Jones Intercable greater access to technology and human resources trained in the telephony area. Through this joint venture with a strategic partner, Jones is well positioned to benefit from shared knowledge of converging technologies. To that end, BCI has already transferred executives to Jones Intercable's corporate headquarters in Englewood, Colorado, with more expected to join their colleagues soon.

A definite benefit of Jones Intercable's new relationship with BCI is the recognition now given to the company by Wall Street. Having had to contend with low performing stock values due to its very complicated organizational and financial structure, Jones's new partnership with BCI has sent the value of its stock on a steady climb upward. In May 1995, the company's stock had realized an impressive 25% increase over the preceding year.

A technological leader, Jones Intercable was one of the earliest cable companies to convert from standard coaxial cable to fiber optics. The company began the fiber optic upgrade of its owned and managed systems more than six years ago. Its Alexandria, Virginia, system is the first fully deployed interactive fiber network. Able to handle 250,000 times as much information as a standard telephone wire, the Alexandria system delivers video, telephone, and high-speed data services.

It is noteworthy that Glenn Jones, the visionary behind the multi-faceted Jones telecommunications empire, is an insatiable reader and a published poet. It's not surprising that he is recognized as one of the cable industry's most innovative leaders, and has staked his claim in the growing success of distance education and the continued success of cable television.

u contributed by Valerie Switzer

Jones, Glenn R. (1930 –)

American business executive, cable television pioneer and entrepreneur; currently Chairman of Jones Education Networks, Inc. and Chairman and Chief Executive Officer of Jones Intercable, Inc., one of the ten largest cable television operators in the U.S. Glenn Jones is primarily known for his cable innovations; his commitment to the concept of distance education; and for conceiving and launching two innovative cable TV channels, Jones Computer Network (JCN) and Mind Extension University (ME/U).

Jones was born in Jackson Center, Pennsylvania in 1930. He earned an undergraduate degree in economics from Allegheny College, and obtained a Juris Doctor degree from the University of Colorado School of Law in 1961. He then served in the U.S. Navy as a bomb disposal officer with a special designation for thermonuclear weapons.

Jones began his career in cable television (CATV) by representing cable companies in their acquisition efforts across the country. In 1964, he put this career on hold to run for the U.S. Congress in Colorado's First Congressional District (Denver). He was defeated, returned to lawyering in mountain towns, and set his sights on acquiring his first cable system.

In 1967, Jones persuaded the owner of the Georgetown, Colorado cable system to accept $1,000 down on a purchase price of $12,000. He raised the down payment by borrowing $400 against his Volkswagen and collecting the remaining money from those of the system's 100 subscribers who had delinquent accounts. A month later, he bought another nearby cable system and persuaded the former owner to stay on as a technician. Together, they strung cable from telephone poles.

With his Colorado base set, Jones widened his search for cable systems and bought one in California. He realized the key to success in cable was financing for the capital-intensive task of buying equipment and supporting the negative cash flows occasioned during the construction phase of new systems. As a result, Jones became the first in the industry to organize public limited partnerships to raise capital to finance cable acquisitions. In 1970, Jones Intercable, Inc. was formed to serve as the vehicle for the blind pool limited partnerships. Larger competitors' adoption of his limited partnership financing strategy has further authenticated Jones's innovative business approach.

Among his creative enterprises are Mind Extension University (ME/U), a cable network delivering distance education courses; Jones Computer Network (JCN), a cable network targeting computer users at all levels; and Jones Interactive, Inc., a provider of digital publishing and multimedia products. He is also the author of the *Jones Cable Television and Information Infrastructure Dictionary*, 4th edition, *Make All America a School* (a book about distance education), and several volumes of poetry.

The recipient of many honors and awards for his contributions to cable television and distance education, Glenn Jones was inducted into Broadcasting and Cable's Hall of Fame in 1994.

u contributed by Kay S. Volkema

Kahn, Irving B. (1918 – 1994)

American businessman and entrepreneur, best known as a cable television pioneer and fiber optics innovator who developed the largest cable system of its time (1959).

Irving B. Kahn, a Newark, New Jersey, native and nephew of songwriter Irving Berlin, joined 20th Century Fox Film Corporation as a public relations official in 1939. He also served in the U.S. Air Force during World War II and rejoined Fox to head TV activities upon his discharge.

In 1951, after 16 years in show business advertising and publicity, Kahn became President and Chairman of Teleprompter. Teleprompter developed a cueing device that displayed script lines and cues for public speakers and actors, then expanded into telecasting big-screen closed-circuit events like boxing and auto racing. In 1959, Kahn bought his first cable television system, then developed it into the largest cable operation of its time. Kahn had become a dominant figure in cable television and a leading visionary for the industry.

In the mid-1960's however, he was convicted of bribery and perjury in connection with paying $15,000 to Johnstown, Pennsylvania, city officials. He served 20 months in prison before his release in 1975. Kahn admitted the payments, but said they were extorted from him for cable franchise renewal. *Fortune* magazine cited him as one of the most successful businessmen in overcoming the stigma of a prison sentence.

While he was serving time at Eglin Air Force Base in Florida, it was reported that Kahn was quietly laying the foundation for a 55-franchise cable system in New Jersey. Upon his release, he formed his own company, Broadband Communications, Inc., to secure films and other programs for pay cable. Kahn also began developing fiber optics technology for cable TV and built a large cable system in Camden, New Jersey. In 1980, Kahn sold his New Jersey franchises to the *New York Times* for $100 million.

In the 1960's he had campaigned for cable's entry into the pay-TV market without success, but was able to attract major investment bankers into cable. Always looking towards the future, Kahn worked to promote satellite distribution of programs and in 1970, with the hiring of top scientists from Bell Laboratories, he formed Times Fiber Communications to develop fiber optics and General Optronics to manufacturer laser diodes for use in fiber optic systems. General Optronics was sold to a British company in 1988.

Kahn died of a heart attack on January 22, 1994, while in Boston for treatment of diabetes and arthritis. A noted connoisseur of food and wine, he was stricken while dining in a Chinese restaurant. Kahn was survived by his wife and two children.

u contributed by Diana L. Hollenbeck

Kahn, Philippe (1952 –)

French-born American mathematician, computer software designer and public speaker, co-founder and CEO of Starfish Software, a company that designs and develops applications and utilities that leverage the Internet, on-line services and computer telephony and founder of Borland International, Inc., a company that designs and develops professional development tools for microcomputers.

Raised in an environment of extraordinary freedom, Kahn was allowed by his widower father to do whatever he wanted as long as he maintained straight A's in class. At age 13, Kahn was taking karate classes. Three years later, he had a brief career as part of the Student Movement during the student unrest that gripped Paris in May 1968. He spent his nights talking politics and meeting and arguing with intellectuals like Jean Paul Sartre. Kahn received his first degree, the U.S. equivalent of a bachelor of arts, around the age of 19. At a very young age, this French mathematician studied in Zurich under Niklaus Wirth — one of the most influential computer scientists of the last decade.

After a post-graduate sabbatical, Kahn settled in St. Paul de Vence, the fabled artist's haven in the hills above Grasse. He had married an aspiring painter, Martine, and soon fathered two daughters. He reports that it was time for him to get serious and get a job. He applied for and won a national fellowship to the University of Nice, where he taught mathematics, experimented with computers and earned his advanced degrees. In 1974 he got involved in writing software for the Micral computer which is now recognized by the Boston Computer Museum as the first ever personal computer, preceding the Altair by as much as nine months. Kahn, however, saw the academic world as repetitive and unchallenging and believed the French computer circles were resting on their laurels after the Micral breakthrough. What he really wanted to do was technical work for an established company like IBM, Apple Computer or Hewlett-Packard (HP). Kahn wanted to do computer programming and work on advanced operating systems.

In 1982, Kahn picked up a copy of *Byte*, the computer industry magazine, and sent telexes to more than 100 corporate advertisers on the West Coast, outlining his talents (among them, fluency in four languages) and his academic and technical experience. He received 11 responses. Leaving Martine in charge of the family and its finances, Kahn scooped up their savings and bought a one-way airline ticket to the West Coast.

There was never a doubt in his mind that he would make it. He said there was no option for failure: he had no contingency plan. Living in a rented room in San Jose, California, he knocked on doors until miraculously one opened — at HP. HP was then assembling a team to build the operating system for the RISC machine. It was Kahn's dream job. He didn't care about the money, but the $40,000-a-year salary was more money than he ever thought he would make. Kahn called home to tell Martine about his great fortune and then hurried through the corporate paperwork, winding up at the personnel office. At the end of receiving the pile of company forms, the personnel officer asked Kahn if he was a United States citizen. Kahn said no, that he had only a passport and a tourist visa.

As a result, he was back on the street. Kahn kept himself alive by doing odd jobs in computer stores, freelance programming and consulting. He kept his dream alive by tinkering in his spare time with the concept, cooked up with a few colleagues in Europe, that would lead to the birth of Borland International. Kahn said one of the early problems with the personal computer was that there were no tools to develop software. So, Kahn and his colleagues built a Pascal development environment which included a compiler, an editor, and a debugger--tools to allow one to build other things. He showed the program to a few large companies, including Microsoft, but they weren't interested. Kahn was sure his new product, dubbed Turbo Pascal, could be a winner, so he formed his own company. As the oft-told history goes, he tricked *Byte* magazine into running his penniless firm's first advertisement on credit. The ad simply described the product and showed its price, an industry-jolting low of $49.95. This start-up business in the top of a garage had $100,000 in orders in the first 30 days.

Kahn is by some accounts brash, caustic and an eccentric renegade. Others label him as articulate, highly intelligent, and gutsy. Also an accomplished flautist and saxophonist, Kahn uses all the complexities in his personality to live his life and run the company he started in 1983.

Despite a lack of venture capital funding, Borland has grown by leaps and bounds. Armed with a mission to deliver software that advances the industry through technological innovation, Borland has established leadership positions with such products as Delphi, Paradox, Borland C++ and Quattro. All of this growth has not been without growing pains, however. In 1994, Borland sold Quattro Pro to Novell for $145 million. Amid great company turmoil, Borland's management is changing, embracing the goal of promising less and delivering more.

Never one to let the grass grow under his feet, Kahn co-founded Starfish Software with Sonia Lee, a noted graphics designer in the Silicon Valley, in 1994. This new company is focused on delivering simple, powerful, high-quality software products that will help people become better organized and more productive using the Internet, on-line services and computer telephony. Starfish Software has established two leading brands on Windows 95: Sidekick and Dashboard.

u contributed by Diana L. Hollenbeck

Kapor, Mitchell D. (1950 –)

American computer expert and entrepreneur whose accomplishments include founding Lotus Development Corporation and organizing the Electronic Frontier Foundation (EFF). Kapor is probably best known for designing the spreadsheet program Lotus 1-2-3.

Mitchell Kapor was born in Brooklyn, New York, on November 1, 1950. While in junior high school, Kapor built a simple computer to enter in a science fair. He participated in summer courses sponsored by the National Science Foundation, but completed only one computer programming course while in high school. After graduation, Kapor went to Yale, where he pursued an inter-disciplinary major in cybernetics that combined studies in psychology, linguistics and computer science. Kapor earned his bachelor's degree from Yale in 1971 and a master's degree in psychology from Boston's Beacon College in 1978. In 1979, he studied at Massachusetts Institute of Technology's (MIT) Sloan School of Management, but later dropped out. A self-described "intellectual gypsy," Kapor soon had held such diverse jobs as radio disc jockey and transcendental meditation instructor.

During his youth, Kapor was discouraged by his father (who owned a small business) from starting his own company. In 1982, however, Kapor founded Lotus Development Corporation. At Lotus, he designed the groundbreaking spreadsheet program Lotus 1-2-3, which has become the world's most widely-used application software program. Although Kapor was never motivated by money, Lotus made him a millionaire and launched his legendary career. He served as Lotus's President and later as Chairman and Chief Executive Officer from 1982 to 1986.

Kapor left Lotus in 1986 and was a visiting scientist for a year at the MIT Center for Cognitive Science and the MIT Artificial Intelligence Laboratory. In 1987, he founded ON Technology, a software company that develops personal computer products to improve workgroup productivity. Kapor served as ON's Chairman and Chief Executive Officer, as well as designing specialized programs, until 1992.

In 1990, Kapor and John Perry Barlow (a retired rancher and former lyricist for the Grateful Dead who writes and lectures about society and communications technology) co-founded the Electronic Frontier Foundation (EFF). A non-profit organization originally located in Cambridge, Massachusetts, and now based in San Francisco, California, EFF is concerned with the development of public policies that will protect civil liberties and competitiveness in the world of advanced communication networks. Formerly Chairman, Kapor continues to serve on EFF's board.

Kapor's intelligence, accomplishments and vision have made him a youthful "elder" statesman in discussions about the convergence of societal issues and emerging technologies. He has testified before the U.S. Congress, and his articles about software design, global communications and civil liberties have been published in such prestigious magazines as *Scientific American* and *Forbes*. Kapor has often described his vision that communications technologies will best be used to bring people together to create vigorous communities in the on-line world. Energy, momentum and positive societal changes will eventually flow from the ongoing dialogue within these communities, says

Kapor. One of Kapor’s personal goals is to be an active participant in bringing his vision to reality as advanced communications technologies increasingly become part of daily life.

In 1992 and 1993, Kapor was Chairman of the Massachusetts Commission on Computer Technology and Law, which explores computer crime in the state. He has also been a member of the National Research Council’s Computer Science and Technology Board, as well as the National Information Infrastructure (NII) Advisory Council. Currently Adjunct Professor with MIT’s Media Arts and Sciences Center, Kapor summarized his life’s goals in the June 23, 1992, issue of *Computerworld:* “My aspiration…[is] to do the right thing, to do well, to be responsible, to leave the world a better place, to make a contribution and one that’s in tune with my own gifts and talents.” It would seem that Mitchell Kapor is well on the way to achieving his life’s goal.

u contributed by Susan P. Sanders

Kappel, Frederick Russell (1902 – 1994)

American engineer-turned-businessman who was the ninth President of American Telephone & Telegraph (AT&T).

Frederick Russell Kappel was born on January 14, 1902, at Albert Lea, Minnesota, the eldest of the five children of Fred Albert and Gertrude May Towle Kappel. His father was the proprietor of a combination cigar and barber shop. At ten years of age Fred earned money as a newsboy, and later he worked as a storekeeper's handyman and as an assistant to a steam fitter.

After graduation from high school, he enrolled at the University of Minnesota in Minneapolis. To meet expenses he found summer employment as a serviceman for the Southern Minnesota Gas & Electric Company. During the school year he worked at odd jobs, as a waiter and as a drummer in a dance band. He also played the drum in the university concert band. Kappel was elected to the Eta Kappa Nu honorary engineering society; and the Phi Sigma Phi honorary music fraternity. He received a bachelor's degree in engineering from the university in June 1924.

After graduating, he accepted a job as a groundman with the Northwestern Bell Telephone Company (an AT&T subsidiary) at a starting salary of $25 a week. In subsequent years he progressed through a wide range of assignments in Minnesota, Nebraska and South Dakota to become AT&T's Vice-President of Operations and Engineering in 1949. For the next four years, the period of the system's greatest growth, he coordinated expansion from this top technical post.

Kappel was then elected President of Western Electric. During his tenure, he oversaw innovations such as the highly successful promotion of phones in color, the first transcontinental coaxial cable, and the first cross-country microwave setup (for transmission, among other things, of TV programs). Western Electric had been acquired by the American Bell Telephone Company in 1882 because it provided a dependable source of telephone equipment. Seven decades later, Western Electric had become the largest of all Bell units with 100,000 employees. At that time, the company made 50,000 different kinds of compatible and interchangeable products, operated 21 plants, and turned out and installed items ranging from relays and rheostats to highly advanced office memorizers and computers.

Kappel came to the presidency of Western Electric with a reputation as a top-flight administrator rather than as a manufacturing and sales specialist. About 90 percent of Western Electric's products were made for the Bell System, and most of the remainder was sold to the U.S. government. As head of Western Electric, Kappel spent only about half the time at his desk, while the rest was spent checking every plant and installation in the company, including the Distant Early Warning Line of radar stations being built in the Arctic for the U.S. government. During his presidency Western Electric's annual sales increased from $1.5 billion to $2.25 billion.

In 1949, the U.S. Department of Justice filed an antitrust suit against AT&T that sought to compel the corporation to dispose of Western Electric and then to divide Western Electric into three parts in order to promote competition in the manufacture of telephones. A consent decree was announced in January 1956 whereby the government agreed to withdraw its plea in exchange for a pledge by AT&T to open up its patent pool to royalty-free licensing by other manufacturers and to disclose its manufacturing costs. In return for Bell patents, an outside company would have to offer the use of its own patents. By the end of 1956, AT&T with its subsidiaries had increased its assets to over $16 billion, making it the world's largest corporation. At this time, the Bell Telephone System employed over 780,000. On September 19, 1956, Kappel was elected the ninth President of AT&T, in succession to Cleo F. Craig, who then became Chairman of the Board.

Kappel retired from AT&T in 1967, but found much to keep him busy. Under President Lyndon B. Johnson, he was Chairman of the Commission on Executive, Legislative and Judicial Salaries, Chairman of the Commission on Postal Organization, Chairman of the Advisory Committee on Top Federal Salaries, and a member of the Special Mediation Board in a 1967 railroad labor dispute. Under President Richard M. Nixon, Kappel was appointed Governor of the U.S. Postal Service and was Chairman of the U.S. Postal Service from 1972 to 1974. He was also appointed by President Nixon to the Advisory Council on Executive Organization. Kappel also held directorships in several corporations and non-profit organizations. Between government assignments, Kappel served with the International Paper Company as Chairman of the Board of Directors from 1969 to 1971 and Chairman of the Executive Committee from 1971 to 1972.

Besides directorships with a number of other organizations, Kappel was the recipient of numerous awards and citations. Among these, he received the Captain of Industry Award from *The Wall Street Journal* in 1973, the Herbert Hoover Medal in 1972, the Henry Laurence Gantt Memorial Gold Medal in 1970, and the Equal Opportunity Medal of the National Urban League in 1966. A chair was endowed in his name at the University of Minnesota Graduate School of Business in 1967 called the "Frederick R. Kappel Professorship in Business and Government Relations."

He was a fellow of the Institute of Electrical and Electronics Engineers (IEEE) and a member of, among others, the U.S. Chamber of Commerce, Telephone Pioneers of America, and American Ordinance Association. In 1964, he was awarded the Presidential Medal of Freedom.

u contributed by Diana L. Hollenbeck

Lamb, Brian P. (1941 –)

American businessman who co-founded and is now the Chief Executive Officer (CEO) of Cable Satellite Public Affairs Network (C-SPAN), a television network created as a public service of cable operating companies which carries Congressional proceedings and select national conferences and forums by satellite to cable systems and other video providers.

Lamb grew up in Lafayette, Indiana. While attending high school and Purdue University, Lamb worked in the city's television and radio stations. His experiences spinning records and selling ads at WASK radio and hosting "Dance Date" on WLFI-TV gave him a taste of what his future endeavors might entail.

After college, Lamb joined the U.S. Navy. His tour included Washington, D.C., with stints at the White House and the Pentagon. In 1967 Lamb went back to WLFI in Lafayette but quickly returned to Washington when a job reporting for United Press International (UPI) Audio became available. Following his UPI work, Lamb worked as a Senate press secretary and then as a White House telecommunications policy staffer.

Lamb's interest in Washington and communications found an outlet when he began publishing and editing the biweekly *The Media Report.* He was also the Washington bureau chief for trade publication *Cablevision.*

From 1977 to 1979 Lamb and some of the larger cable multiple system operators (MSOs) worked together to create C-SPAN, a non-profit, basic cable channel whose mission was to cover the U.S. House of Representatives' proceedings. This new public service medium was based on Lamb's idea to show the public, rather than tell them, important day-to-day news concerning their national government. Additionally, the MSOs that carried C-SPAN positioned it as an outstanding public service, thus benefiting from its public relations value. In 1986 many MSOs made room for its sister network, C-SPAN 2, the network that carries U.S. Senate proceedings.

C-SPAN was one of the earliest offerings on cable. Today, with more than 60 million homes, it remains the eighth largest basic cable network. C-SPAN 2 is available in more than 40 million homes; however, it has faced greater challenges to its growth.

When Congress is not in session, C-SPAN and C-SPAN 2 air a variety of live and recorded national events, including press conferences, select speeches, panel discussions and interview programs from Washington and around the country. The non-profit, 200-employee company also offers two audio networks. Lamb is often seen on his cable channel as host of *Booknotes*, *The Washington Journal* and a number of specials.

But CEO Brian Lamb has a plan. Expanded and diverse coverage are part of it. From August to October 1994, perhaps epitomizing what educational television does best, C-SPAN broadcast the reenactment of seven debates between Abraham Lincoln and Stephen Douglas that originally took place in 1858. Additionally, C-SPAN launched its innovative classroom on wheels -- "The C-SPAN School Bus" -- in October 1994. Each year, the 45 foot custom coach travels more than 40,000 miles, visiting high schools at the invitation of local cable operators. The project, which won the cable industry's coveted Golden CableAce Award in 1995, has been such a success for the network that the C-SPAN board authorized the launching of a second "School Bus" in January 1996.

Brian Lamb has kept close ties to his Indiana roots. When Lafayette radio station WASK held its 50th anniversary in 1993, Lamb was among the former on-air talents at the celebration. He had candid photos taken with various attendees and once back in his Washington, D.C., office wrote notes of thanks on the photos and sent them back to his former colleagues.

Lamb's formative Indiana years seem to have provided him with a sense of humility. But more importantly, the years spent honing his skills have made Brian Lamb eminently qualified to show, not tell, the engrossing daily happenings in Washington, D.C., that affect every American.

u contributed by Michele Messenger

Leibniz, Gottfried Wilhelm (1646 – 1716)

German philosopher, mathematician, scientist, diplomat and inventor of the Leibniz Computer.

Born in Leipzig, Germany in 1646, Leibniz was educated at the universities of Leipzig and Nuremberg, receiving a doctorate in law at the latter. Out of financial necessity, he then began a lifelong career in the service of royalty and nobility, which enabled him to travel, meet many influential and scholarly people, and follow his own wide-ranging intellectual pursuits.

Leibniz's contributions to science and society were many over his 70 years. In 1666, he conceived the idea of a universal language, the theoretical basis of modern computers. Several years later, Leibniz constructed a calculating machine which he presented to London's Royal Society. In 1676, he developed the dynamic theory of motion.

In the 1680's, Leibniz was involved in a hotly debated controversy over whether he or Sir Isaac Newton invented integral and differential calculus. The Royal Society eventually ruled in Newton's favor in 1711, despite the publication of Leibniz's work three years earlier than Newton's. The ruling, however, did not satisfactorily resolve the controversy, and today Leibniz is credited with laying the foundations of calculus.

Inspired by French physicist Blaise Pascal's *Pascaline*, he finally perfected the Leibniz calculator/computer in 1694. It multiplied by performing repetitive additions — an algorithm still used in modern computers. In addition, he devised the binary system of numeration used in today's computer operation.

Through royal connections, Leibniz was influential in the founding of the German Academy of Sciences in Berlin in 1700, and served as its first President. His extensive contributions and writings covered such diverse fields as theology, politics, metaphysics, geology, natural science, optics, history, symbolic logic and law, among others.

Suffering terribly from gout, Gottfried Wilhelm Leibniz died in Hanover, Germany, in 1716. He is recognized today as one of the most brilliant minds of his time.

u contributed by Kay S. Volkema

Levin, Gerald M. (1939 –   )

American businessman, currently the Chairman and Chief Executive Officer (CEO) of Time Warner Inc., the New York-based media and entertainment giant. Its principal business units include Time Inc., Time Warner Cable, Home Box Office (HBO), Warner Bros. and Warner Music Group. Music operations include Warner Bros. Records, Atlantic and Elektra. Publishing interests include *Sports Illustrated, People, Time, Fortune* and *Entertainment Weekly* magazines. Time Warner is so large that it owns more copyrighted material than any other entity. Additionally, it has the means to distribute its copyrighted materials.

Jerry Levin graduated from Haverford College and the University of Pennsylvania Law School. He practiced law for four years and then worked at an investment/management company for four additional years.

When cable network Home Box Office (HBO) was in development in 1972, Levin was hired by the parent company, Time Incorporated. He started as HBO's Vice President of Programming and worked his way up to President, CEO and Chairman of the network. Under Levin's leadership, HBO made the bold move to utilize satellites for transmission delivery. This new delivery method gave the entire cable industry its format for future growth.

In 1979, Levin was named Time Inc.'s Group Vice President. For the next five years he oversaw not only HBO but also Time-Life Films and the group's cable company, American Television and Communications Corporation (ATC). Later Levin became Chief Operating Officer and Vice Chairman of Time Warner Inc., the new company formed under Levin's guidance when Time Inc. and Warner Communications Inc. merged (1990).

The few years following the merger were somewhat hectic for Time Warner and included a variety of personnel changes. In 1992 Levin was named President and co-CEO of Time Warner Inc. Ten months later, Levin became the sole CEO. Two months after that, Chairman of the Board was added to his title.

Presumably, once Levin covered all the steps of the corporate ladder, he could get down to the futuristic side of his business. In 1992 Levin announced that Time Warner would introduce Full Service Network (FSN), an on-demand, interactive network. He also announced that Time Warner would spend $5 billion dollars over five years to develop it. In December 1994, Levin publicly demonstrated this elaborate, working interactive television system in test-market Orlando, Florida.

In his demonstration, he ordered movies, fast-forwarded to the "good" parts and paused. Then he shopped at a virtual mall, including a stop and purchase at the virtual Warner Brothers Studio Store. He connected with another viewer — real, not virtual — and played a card game. Then he went back to the movies to finish off those good parts. The audience for Levin's demonstration, cynical reporters, applauded wildly. Levin's remarkable toy, video on demand, needed much more refining in order to get past the test-market stage. It was not certain whether such a service was warranted or could be cost-effective. As the scope of the work yet to be completed became painstakingly clear, the company embarked on another daunting task — the start-up of a new broadcast television network. Warner Brothers, the company's studio unit, entered into a joint venture with former Fox Broadcasting Company (Fox) President Jamie Kellner and launched The Warner Brothers Network (WB) in January 1995.

An early 1995 *Forbes* magazine article speculated about Time Warner's management and Levin's abilities in particular. However, for those who have watched this entrepreneur, his determined passion and track record of continued successes leave no doubt as to his or his company's future.

u contributed by Michele Messenger

Local Access Programming

Local access programming is produced using the television production facilities, equipment and cable channels that are provided by local cable system operators. Since 1972, the Federal Communications Commission (FCC) has required large cable systems to make channels available at no cost for public, educational and governmental (PEG) programming. Community access channels, which are leased by community groups, can also be made available by the cable operator. Local origination, often confused with local access, is programming that is produced by the cable operator.

Public access is free to the public and available on a first-come, first-served basis. Typically, the cable operator trains the volunteer production personnel, who work as camera operators, editors, production crew members, and even on-camera talent. Local access production services usually include both studio and remote production capability.

Educational access programming can be produced by local educational institutions ranging from elementary to adult education, and can include telecourses offered by colleges. Some educational access channels carry student-produced programs, school menus, 24-hour bulletin boards or live telecasts of school board meetings and other local events.

Governmental access channels are programmed by municipal and local government agencies. They are often used to telecast city council meetings, informational programs to explain ordinances, training for government employees, public safety programs or a forum for the discussion of community issues.

Cable operators are not permitted to control the content of these channels and cannot be held liable for their content. Local access programs are often aired, then repeated at various times to ensure the best possible audience viewing; however one problem that plagues most local access is the lack of a suitable method of publicizing programs.

In the 1980's, cable operators in many areas promised to build elaborate local access facilities in order to demonstrate their commitment to the community, and thus gain favorable consideration for the local cable franchise. In some cases, however, the facilities were built but seldom used, while in other cable systems the facilities are used heavily. In 1991, approximately 11,000 cable systems had local access channels. Together, they provided over 12,600 hours of programming each week.

A 1984 federal law guarantees free time on public access channels and forbids censorship. Efforts to authorize cable operators to ban obscene materials, sexually explicit conduct or censure program content have been blocked by the courts.

Community access channels are similar to the local access channels; however, they are leased by a group that controls the content of programming. Community access channels are not open to the general public as the public access channels are.

In areas where the local access channels have not been used by the public, educational institutions or government, the channels often blend with community access channels. This has created some dilemmas, since local public access is an electronic "soapbox" that is open for anyone to say anything, while the programming on community access channels is controlled by the group that pays for the channel.

The heart of local access programming is the thousands of volunteers who serve as writers, producers, directors and crew members for the programs. Cable system operators provide the training, equipment and access channel, but without volunteers there would be no local access or community access programming.

Local origination programming, sometimes confused with local access programming, consists of television programs that are produced by the local cable operator. These professional productions often cover topics of local interest, but many are also sent to other cable systems for viewing. Unlike local access programming, local origination programming is not an open forum for people to say anything they want and the content is controlled by the local system operator. Local origination programming can be supported by local advertising.

u contributed by Paul Stranahan

Lovelace, Augusta Ada King, countess of, (1815 – 1852)

Also known as **Lady Byron**. An English writer and mathematician, she is regarded as the first computer programmer, and ADA — the U.S. Defense Department's primary programming language — is her namesake.

The only legitimate daughter of poet Lord Byron, Lovelace's parents legally separated two months after her birth, and she never saw her famous father again. Well educated in geometry, astronomy and mathematics, she was socially acquainted with many leading Victorian figures. She married William King (the eighth Baron King) in 1835, and become countess of Lovelace three years later when he was named an earl.

But it was her friendship with computer pioneer Charles Babbage that would help develop and establish Lovelace's own particular genius. She first became interested in his computing machines several years before marrying King. Then in 1843, Lovelace published her translation (from French to English) of L. P. Menabrea's paper describing Babbage's Analytical Engine and its principles. She included her own explanatory notes, extending Babbage's ideas. She also discussed such things as programming techniques, sample programs, and the potential emulation of intelligent human activities (for example, playing chess or composing music) by computing machines. Her other contributions to Babbage's project included inventing the subroutine and the programming loop.

Lady Ada Lovelace died at age 36 from cancer in London, having first helped the world understand her friend Babbage's brilliant computing theories and then contributing her own on computer programming.

u contributed by Kay S. Volkema

Magness, Bob (1924 –)

American cable television pioneer, entrepreneur, and former Oklahoma cattle rancher. Bob Magness is best known as the founder and current Chairman of the Board for Tele-Communications, Inc. (TCI), the largest multiple system cable operator (MSO) in the United States.

Bob Magness was born on June 3, 1924, in Clinton, Oklahoma. He grew up in the same area and graduated from Southwestern State College in Wetherford, Oklahoma, in 1949. He married his future cable television partner, Betsy Preston, on June 21, 1949.

An Oklahoma cottonseed salesman and part-time cattle rancher in the early 1950's, Magness had the good fortune to run into a group of people who had just built their first cable television system in Paducah, Texas. The idea of investing in the young cable television industry was of great interest to Magness. Soon, he and Betsy sold their cattle and re-financed their home in order to invest in a cable system of their own.

By 1956, Bob and Betsy Magness had established their first cable system in Memphis, Texas, securing a total of 700 subscribers. Magness actually installed the wire on existing telephone poles that linked the system. Betsy handled the management side of the business, running the office and handling the accounting responsibilities. Their second cable venture in Plainview, Texas, followed shortly thereafter. They acquired a total of 3,000 additional subscribers with this second system.

In 1958, they joined forces with Jack Gallivan of Reno, Nevada, and George Hatch and Blaine Glasmann, television entrepreneurs in Salt Lake City, Utah. This group formed a partnership that elected to focus its energy on Montana. So in 1958, Bob and Betsy Magness moved to Bozeman, Montana. During the next seven years, they developed six new systems in Montana that reached more than 12,000 customers.

In 1965, Bob and Betsy determined the company needed a more centralized location, so they moved to Denver, Colorado. This new operation, in a brand-new location, boasted a total of 12 employees. It was actually composed of two different entities — Community Television, Inc., the cable company, and Western Microwave, Inc., a microwave common carrier. In 1968, they joined the two separate organizations under one umbrella company, thus creating Tele-Communications, Inc. (TCI).

TCI issued its first public stock offering in 1970, which raised nearly $6.7 million. In 1972, Dr. John C. Malone joined TCI, and one year later, he was named President and Chief Executive Officer (CEO). At that time, Bob Magness became Chairman of the Board, the same position he still holds today. The company became the tenth largest cable company in 1970; 12 years later, in 1982, it became the largest cable operator in the country.

Through the years, the company has secured a variety of programming options for its viewers through investments in a number of entertainment services. It has invested in the Black Entertainment Television Network (BET), Cable News Network (CNN), the

Discovery Channel and American Movie Classics (AMC). In addition, it created Liberty Media, which was spun off in 1991 and then reacquired in 1994.

Today, TCI has more than 24,000 employees and serves more than 12.7 million subscribers in the United States . In addition, the company entered into cable television joint ventures in Japan and Argentina in 1994. Looking to the future, TCI has its eye on providing video telephony and is involved in a number of test projects throughout the United States and in the United Kingdom for this future service.

A long-time Denver resident, Bob Magness is a sought-after board member. He currently serves on the Board of Trustees of the University of Denver and the Denver Art Museum and is a member of the Board of Directors of The National Western Stock Show Association (headquartered in Denver) as well as the Board of Trustees of the Denver Area Council of the Boy Scouts of America. He is also a member of the Board of Trustees of the Arabian Horse Trust.

u contributed by Valerie Switzer

Malarkey, Martin F. (1918 –   )

American pioneer in the cable television industry and currently the Chairman of the Board of Malarkey, Taylor/EMCI in Washington, D.C., a telecommunications consulting company. Malarkey is generally known for founding one of the first cable systems in the United States, Trans-Video Corporation.

Just before the start of World War II, the new medium of television was on the brink of growth. The war, however, effectively shut down the entire industry. But when the war was over, the television business took off again. One of the driving forces behind the television rush was that countless new stations were trying to get on the air. These stations had to apply to the Federal Communications Commission (FCC) in order to get broadcasting and frequency rights.

In a very short time, the FCC was overwhelmed with new station applications and announced a freeze. From 1948 to 1952, no new television stations could get approval to use the airwaves. This meant that if a particular market, regardless of size, didn't already have a television station up and running, it wasn't going to get one any time soon. The existing industry, as a whole, seemed to use this time to regroup and concentrate on the business at hand.

Included in the industry participants who used the freeze to their advantage was Martin Malarkey. Malarkey, a graduate of LaSalle University and a World War II U.S. Navy veteran, was active in the family's music stores, Malarkey's Inc. Located in mountainous Pottsville, Pennsylvania, the stores had a large inventory of RCA television sets in 1949 and, since only a few residents could receive television transmission due to the surrounding hills, the sets weren't selling very quickly. Technology for master antennas, such as those used for apartment buildings, had just been developed by Jerrold Electronics Corporation. So it wasn't a huge leap in theory to consider the same basic idea for geographically isolated areas such as Pottsville.

Malarkey stated in his biography for the The National Cable Television Center and Museum that he was in New York, staying at the brand new Waldorf-Astoria, on a buying trip. The similarities in connecting hotel rooms and houses hit him when he noticed the room's 10-inch RCA television set. Surprised at the fine reception, he poked around and discovered the cable. He contacted the hotel's engineering department and they showed him the new master antenna system. Malarkey's Inc. was one of the largest RCA television, radio and record dealers in the country, so it was natural to approach RCA about a cooperative plan — one that would use this technology to receive clear television signals and transmit them via cable to houses in the valley. Malarkey easily convinced RCA that a similar master antenna and cable connection would be beneficial to both of them. RCA agreed to provide free engineering talent if Malarkey agreed to use RCA equipment.

After some experimentation, a mountain-top site was located and a few houses were hooked to the antenna. Malarkey's initial plan was to sell more television sets, but he quickly saw that this new cable system could be a self-sustaining business. In late 1950, Malarkey opened up an office in Pottsville. His customers paid $135 for the initial connection and $3.75 each month to the new Trans-Video Corporation. He not only wired Pottsville but then also proceeded to wire other communities and buy up additional systems. One thing that eventually differentiated Malarkey from his fellow cable pioneers was his origination of televised shows. In 1953, Malarkey broadcast a show from the antenna site that consisted of interviews with everyone from local politicians to the winner of the Soap Box Derby. This was a short-lived sideline, but it no doubt had an influence on potential customers who were the stars of his show.

After the FCC freeze was lifted in 1952, cable operators worried that new broadcast stations would be licensed and their cable technology might become obsolete. Soon, however, it became apparent that the cost of building new television stations would be prohibitive for many towns and cities; so cable continued to be a cost-effective way to connect and broadcast to smaller, isolated areas of the country. From this point on, cable television grew as fast as connections could be made.

In the mid-1950's, Malarkey's broadcasting interests led him to buy two Pennsylvania radio stations, one in Altoona and the other in Shenandoah. Malarkey was very interested in the radio business and considered getting into the television station business as well; but people kept coming to him with cable-related questions since he was so knowledgeable. Finally, in 1964 he opened Malarkey and Associates, a one-man cable system consulting company. A year later, he and Archer Taylor became partners. The name of the company became Malarkey Taylor and Associates, and new employees were added to the payroll. Today, with Malarkey as Chairman, Malarkey, Taylor/EMCI is a respected consulting firm in the telecommunications industry. He has also been an investor in the real estate market in Washington D.C., converting hotels to condominiums.

Malarkey's experiences in cable provided him with an exciting career. Seeing the immediate need for an organized trade group, he co-founded the National Cable Television Association (NCTA) and served as its President for five terms. Malarkey's cable career has included the building and operating of a total of six cable systems throughout the eastern United States. His knowledge in all aspects of the industry, including financial, management, political and policy, have made him one of the most respected leaders in the field. From publishing articles and reports on cable TV to acting as a legislative consultant for the industry, Malarkey not only gave shape to the technology, but also helped give it life and a future.

Cable television is an industry that has been based on demand. Consumers wanted to see television and they did not want their town's location to stop them from receiving it. Certainly they would invest in television sets if they could receive television shows. Men like Robert Tarlton and his Lansford, Pennsylvania, system; Ed Parsons and his system in Astoria, Oregon; and Martin Malarkey not only recognized the market for television, but they also saw both the short- and long-term benefits in providing television signals for their communities. Short term, they would sell more TV sets since they were all in the same appliance business. Long term, they would bring a brand new, valuable service to their neighbors who might otherwise have to go without. Television itself would not have grown without men like Martin Malarkey.

u contributed by Michele Messenger

Malone, John C. (1941 –)

American cable television company executive. Currently President and Chief Executive Officer of Tele-Communications, Inc. (TCI), the largest cable company in the United States.

With a reputation for shrewd negotiating and a propensity for mega mergers, John C. Malone is one of the most widely respected people in the cable television (CATV) industry. Malone has been President and Chief Executive Officer of Tele-Communications, Inc., based in Englewood, Colorado, since 1973. He also is Chairman of the Board of Directors for Cable Television Laboratories, Inc. (CableLabs), in Boulder, Colorado.

John Malone was born March 7, 1941, in Milford, Connecticut. He was a Phi Beta Kappa and merit scholar at Yale University, where he received a BS in Electrical Engineering and Economics in l963. He earned also a Master of Science degree in Industrial Management from the Johns Hopkins University in 1964. He then earned a Doctor of Philosophy (Ph.D.) in Operations Research from Johns Hopkins in 1967.

On September 7, 1963, he married Leslie Ann Evans. Dr. and Mrs. Malone have two grown children, Tracy and Evan.

Malone began his career in 1963 at Bell Telephone Laboratories/AT&T, where he worked in economic planning and research and development. In l968, he joined McKinsey & Company. In 1970, he was named Group Vice President at General Instrument Corporation based in San Diego. He was later named President of Jerrold Electronics, a division of General Instrument.

A recipient of numerous awards, he was given an Honorary Degree for Doctorate of Human Letters from the University of Denver in 1992. In 1993, he received the Bronze Award in the *Financial World* CEO of the Year Competition. In 1994, he received the Hopkins Distinguished Alumnus Award.

Malone joined Tele-Communications, Inc. in 1973. Since that time, he has earned a reputation for negotiating transactions highly favorable to TCI. One of the first cable agreements he finalized was the cable contract with the city of Vail, Colorado. In 1977, after restructuring TCI’s debt, he negotiated contracts for the organization to purchase cable franchises in several large cities, many at sizable discounts.

Following the deregulation of cable in 1984, TCI aggressively continued its expansion in the cable industry, purchasing a total of more than 150 cable companies in the late 1980’s. In 1986, TCI secured control over United Artists Communications, which later became United Artists Entertainment (UAE). In 1987, TCI purchased Heritage Communications, which included a system in Dallas.

Realizing that TCI would need a vast amount of programming options, Malone and TCI helped finance a number of programming services in exchange for stock ownership.

Some of these included Black Entertainment Television in l979, the Discovery Channel in 1986 and the American Movie Classics Channel in 1987.

In succeeding years, TCI continued to undertake a series of complex negotiations in which it bought and sold numerous entertainment groups and cable companies. Liberty Media, based in Denver, Colorado, was one of the companies which was formed by being spun off as a separate company, and then became part of TCI once again in 1994. That same year, TCI, U S WEST and AT&T began to test video on demand services in the Denver market.

John Malone may be best known for negotiating the mega merger of TCI and Bell Atlantic, one of the largest of the seven regional Bell operating companies (RBOCs). In October 1993, both organizations jointly announced a merger of TCI and Bell Atlantic. This was very big news, indeed, as it is still regarded as possibly the biggest merger ever between two organizations in the United States. Some within the industry estimated the value of this merger to be between $30 and $32 billion.

The mega merger was not meant to be, however. Four months later, in February 1994, the highly publicized agreement dissolved. Much of the reason is attributed to the Federal Communications Commission's decision that month to continue the rate structure freeze on cable rates. It would be an understatement to note that Malone was emphatically disappointed with the FCC and Chairman Reed Hundt's decision to continue to keep cable rates in limbo.

Undaunted, however, Malone has continued his expansion operation for TCI. Much of that expansion has come from its growing international cable operation. Published reports indicate that two-thirds of TCI's current market value is based on non-domestic cable business.

According to public statements, by the end of 1996 TCI plans to have all fiber optics laid for its U.S. cable subscribers. The company is currently working with private vendors in the development of video servers and television set-top control boxes that will be part of each in-home installation.

u contributed by Valerie Switzer

Marconi, Guglielmo (1874 – 1937)

Italian engineer and inventor, best known for successfully developing wireless telegraphy.

Marconi was born in Bologna, Italy, in 1874. He quickly became interested in science, and was formally educated first by tutors and later at the University of Bologna. Inspired by German physicist Heinrich Hertz, who discovered electromagnetic radiation, 20-year-old Marconi began initial experiments at his father's estate, sending and receiving telegraph messages in Morse Code without using wire. This first attempt at wireless telegraphy proved a limited but exciting success, so Marconi offered his invention to the Italian government, which rejected it. He then went to Great Britain in 1896 to continue his work, and in June filed the first patent there for a practical system of wireless telegraphy.

The next year he formed a company to explore commercial wireless applications, later known as Marconi's Wireless Telegraph Company, Ltd., which proved very profitable for him. His experiments continued and he began sending signals over increasing distances. In 1899, Marconi established wireless communication across the English Channel. That same year, his invention first saved lives at sea when help was summoned by wireless for a sinking lightship.

In 1900, Marconi filed British patent No. 7777 for wireless improvements that enabled several stations to operate on different wavelengths without interference. This was overturned 43 years later by the U.S. Supreme Court, which ruled that other scientists, including Sir Oliver Lodge, had priority in developing these particular innovations.

With great fanfare in Newfoundland, Canada, Marconi received the first transatlantic telegraphic radio transmission from Cornwall, England, in 1901. Against prevailing scientific theory, he had correctly argued that long radio waves would follow the Earth's curvature. This historic transmission proved Marconi's theory and was the beginning of worldwide radio communications.

Because of its obvious maritime benefits, Marconi's system was soon adopted by the British and Italian navies. And in 1907, transatlantic wireless telegraph service was finally available for public use. For his work in wireless telegraphy, Marconi received honors from many countries and was awarded the 1909 Nobel Prize in Physics, which he shared with Karl Ferdinand Braun, a German physicist.

Other important communication devices that Marconi patented include the magnetic detector in 1902 and the horizontal directional aerial in 1905. He also devised the radio direction finder, used by ships and airplanes to fix their positions at sea. During World War I, he became interested in shorter wavelengths and experimented with them throughout his later years. He also pioneered the use of ultrahigh-frequency waves for voice radio communication. In 1929, he was named a marquis and nominated to the Italian senate. In charge of scientific research during Benito Mussolini's reign, he died in Rome in 1937.

u contributed by Kay S. Volkema

Master Antenna Television (MATV) and Satellite Master Antenna Television (SMATV)

Methods of receiving and distributing television signals to viewers. Typically, they are used to provide service to hotels, apartment buildings, mobile home parks and other locations where it is impractical for each viewer to have an individual antenna.

Master Antenna Television (MATV)
Master Antenna Television (MATV) is a signal distribution system that uses a central antenna to receive off-air signals, then distributes them to viewers via cable. These miniature cable systems are used to provide service to multiple dwelling units (MDUs) such as hotels and apartments.

An MATV system typically includes an antenna to receive signals, a headend facility to process the signals for distribution, and a cable distribution system that carries the signals to individual sites.

MATV systems are more common in European and Third World countries where the cost of building a cable system is prohibitive. Historically, in countries where use of the airwaves has been tightly controlled for political and ideological purposes, MATV allows greater government control of the programming that people watch.

Early Community Antenna Television (CATV) systems in the United States were MATV systems. These early cable systems placed an antenna in a location to receive distant signals, then delivered programming to homes using *twin lead* wire, a forerunner of coaxial cable.

Satellite Master Antenna Television (SMATV)
Satellite Master Antenna Television (SMATV), also called *private cable,* is a small cable signal distribution system that receives its signals from a satellite, then distributes them to viewers via cable, microwave or infrared light links. SMATV is used to provide television to apartments, mobile home parks or condominiums that are on private property.

Since SMATV signals do not cross city or county streets, they are not regulated by the FCC and do not require franchises. SMATV systems utilize the same type of satellite dishes that are used by cable systems as their down-link, and they can receive the same programming that cable systems carry. In some markets, SMATV operators are able to compete with cable systems because SMATV operators pay the landlord a percentage of the gross revenues for the right to provide the signals to tenants. A typical agreement between the landlord and the SMATV operator is exclusive and prevents the cable operator from offering services on the property.

u contributed by Paul Stranahan

Mauchly, John William (1907 – 1980)

American physicist and engineer, primarily known for co-inventing the first electronic programmable computer (ENIAC), the first American stored-program computer (BINAC), and the first commercially produced electronic computer (UNIVAC) — all in collaboration with John Presper Eckert, Jr.

Mauchly was born in Cincinnati, Ohio, in 1907. He received his degree in physics from Johns Hopkins University and taught electrical engineering for several years at the University of Pennsylvania in Philadelphia.

From 1942 to 1946, Mauchly worked with fellow professor John Presper Eckert, Jr. at the university's Moore School of Electrical Engineering on a programmable computer without moving parts. Their successful effort — sponsored by the U.S. Army — was called ENIAC (Electronic Numerical Integrator and Computer). ENIAC was almost a thousand times faster than Howard Aiken's Harvard Mark I, completed just two years earlier in 1944. Using 18,000 electronic vacuum tubes and capable of 5,000 calculations per second, ENIAC spawned new terms such as *super brain*, used in association with computers. The U.S. Army used the 30-ton ENIAC for military calculations.

While still at the Moore School, Mauchly and Eckert teamed up again (this time with Hungarian-American mathematician John von Neumann) to add a stored-program element to a computer. At the time, computer programs were separate from the machine; changing them required much effort and many man-hours. The stored-program could be kept in the machine's memory just like data, however, and could be accessed and changed just as easily. Eckert and Mauchly finally developed a stored-program computer in 1949 while running their own company, Eckert-Mauchly Corporation. The new machine was called BINAC (Binary Automatic Computer), and it is considered the first American stored-program computer.

Remington Rand bought Mauchly and Eckert's firm in 1950, and Mauchly stayed on as Director of Special Projects. The next year, the company introduced the first electronic computer to be commercially marketed, the UNIVAC (Universal Automatic Computer), started several years earlier by Mauchly and Eckert. The U.S. Census Bureau bought the first UNIVAC to compile the 1950 census.

After leaving Remington Rand, Mauchly held high-level executive positions with various business machine firms. Over the years, he received numerous honors for his contributions to the field of computers. John W. Mauchly died in 1980 in Ambler, Pennsylvania. He is remembered primarily for co-creating the prototype for today's digital computers.

u contributed by Kay S. Volkema

Maxwell, James Clerk (1831 – 1879)

Scottish physicist, considered one of history's greatest scientists for his breakthrough theory of electromagnetic radiation.

Maxwell was born in Edinburgh, Scotland in 1831 and was educated at Edinburgh Academy and the universities of Edinburgh and Cambridge. In 1854, he obtained his degree in mathematics from Trinity College, Cambridge, where he had received prizes and honors in his field. He went on to teach natural philosophy and physics at Marischal College, Aberdeen and King's College, London, until 1865, when he retired to continue his research at his Scottish home. In 1871, he came out of retirement to supervise construction of the Cavendish laboratory at Cambridge, where he became the first professor of experimental physics.

Continuing the work of British scientist Michael Faraday, Maxwell focused on electricity and magnetism. He theorized that electromagnetic waves could move through space and be generated in a laboratory. He deduced that the speed of these waves is the same as that of light, and theorized therefore that light is an electromagnetic phenomenon. In 1888, German physicist Heinrich Hertz performed experiments that corroborated Maxwell's theories.

Some of Maxwell's other important contributions included the study of Saturn's rings; further development of the kinetic theory of gases; and investigation of color blindness, color vision and the creation of the first color photograph.

James Clerk Maxwell died in Cambridge in 1879 at the age of 48. His legacy was the Maxwell field equations, which express all the fundamental laws of light, electricity and magnetism in a few mathematical equations. The electromagnetic unit of magnetic flux, the maxwell, is his namesake.

u contributed by Kay S. Volkema

McCaw, Craig O. (1949 –)

American telecommunications executive, entrepreneur, strategist, former Chairman and Chief Executive Officer of McCaw Cellular Communications, Inc., which was purchased by American Telephone & Telegraph (AT&T) in 1994. He is current Chairman and Chief Executive Officer of Teledesic Corporation based in Kirkland, Washington, as well as ALAACR Communications. Craig McCaw is best known for having created the largest cellular phone company in the United States.

Craig McCaw was born in 1949 in Centralia, Washington, a small community in the western part of the state, and grew up in Seattle. He is one of four sons of the late John Elroy McCaw, founder of Centralia's first radio station in 1937 and one of its first cable TV company operators. In 1969, McCaw's father passed away unexpectedly. A student at Stanford University at the time, Craig McCaw completed college and graduated in 1973.

Following graduation, McCaw took over the management of the small cable television company in Centralia, which he co-owned with his three brothers. McCaw implemented the strategy his father had used: that of securing loans against the small cable business to buy other cable entities. He also drastically reduced operating costs, improved the quality of programming, and, in turn, increased cable subscriptions. Under his direction, the company grew from a one-system operation serving 4,000 subscribers to the twentieth largest cable system in the country. When he sold the cable division in 1987 for $755 million, it had a total of 450,000 subscribers.

In 1974, having recognized the coming need for alternatives to traditional telephone-based communications, McCaw expanded the company's services by entering the paging and conventional mobile telephone industries. McCaw's paging business grew dramatically to a customer base of more than 320,000 subscribers in 13 states and was the fifth largest operator in the country when he sold the company in 1994.

A visionary, McCaw realized in 1981 that wireless communications was the wave of the very near future. During that year, he committed his company to developing broad-based cellular communications. In the decade that followed, McCaw Cellular Communications became the country's largest cellular telephone company, deploying cellular systems in more than 100 major American cities. The combined market potential was estimated at more than 100 million customers. McCaw also expanded the company to include wireless data transmission, personal communications services (PCS), air-to-ground phone service (marketed as Claircom), and satellite communications.

A shining example of having created the right company at the right time, Craig McCaw realized that in order for AT&T to get back into the wireless communications business, its only option was to purchase McCaw Cellular Communications. (At the time of the mandated divestiture of its seven Bell operating companies in 1984, AT&T had disregarded cellular communications as a future telephone technology, believing its popularity would be minimal at best. It chose instead to enter the computer market.)

It was in 1990 that Craig McCaw first approached AT&T about its possible interest in purchasing McCaw Cellular. Four years of negotiations followed. In September 1994, AT&T finalized its discussions with McCaw and bought McCaw Cellular Communications for a record $12.6 billion. This was one of the largest corporate mergers in American history. In the buy-out, Craig McCaw became the largest single shareholder of AT&T stock, estimated at 14 million shares. Following the merger, AT&T invited Craig McCaw to attend its monthly board meetings at corporate headquarters in New Jersey. McCaw declined, however.

It soon became clear that Craig McCaw wished to remain in the telecommunications industry. In October 1994, McCaw notified AT&T that he would be a participant in the auction to secure airwave licenses from the Federal Communications Commission (FCC) starting in early December. Indeed, beginning December 5, 1994, McCaw entered bids for his new ALAACR Communications to secure airwave rights for wireless telephone services in some of the country's prime markets, including cities in California and New York. However, in early March 1995, he dropped out of the 100th round of bidding. Not an inexpensive venture, the bidding price for the Los Angeles license alone had escalated to $493.5 million at the time McCaw withdrew from the auction. It remains to be seen what lies ahead for Craig McCaw and his new ALAACR Communications.

Craig McCaw is also involved in a number of other businesses, including a joint venture with Microsoft's co-founder William "Bill" Gates. In addition, McCaw is Chairman and Chief Executive Officer of Teledesic Corporation, which plans to launch 840 satellites by the year 2001. This satellite network is designed to provide broadband communications internationally, especially in underdeveloped and more remote areas of the world. Obviously, this will be an expensive undertaking. Consequently, Teledesic intends to raise $9 billion to help finance the endeavor.

An active participant in the telecommunications industry, Craig McCaw is a past director of several cable television industry groups. He was appointed to the National Security Telecommunications Advisory Committee (NSTAC) by President Ronald Reagan. In addition, he also serves on the American Enterprise Institute Board of Directors. McCaw and his wife live in Seattle.

u contributed by Valerie Switzer

McConnell, Joseph Howard (1906 –   )

American broadcasting and satellite company executive and lawyer.

Born in Chester, South Carolina, on May 13, 1906, Joseph Howard McConnell is the son of Joseph Moore and Eliza Howard Riggs McConnell. He was raised in Davidson, North Carolina, where he attended public school and Davidson College, where his father was the Dean. He played varsity football for three years, was President of the senior class, and was a member of Kappa Alpha fraternity. After receiving his Bachelor of Science degree in chemistry in 1927, McConnell taught chemistry and was the football coach at the Woodberry Forest Preparatory School in Virginia.

In 1928, McConnell decided that law was to be his profession and entered the University of Virginia. He continued his coaching football with the school's freshman team and acted as scout for the varsity team. In 1931, he graduated with a Bachelor of Laws degree and was elected into membership of Phi Beta Kappa. After a year with a law firm in West Palm Beach, Florida, McConnell joined a law firm in Charlotte, North Carolina. In 1933, he accepted a position on the legal staff of the National Radio Association (NRA) in Washington, D.C. He was Director of one of the agency's three legal sections at the time the NRA was dissolved in 1936.

The young lawyer's first association with the Radio Corporation of America (RCA) began when he joined the New York City law firm of Cotton, Franklin, Wright and Gordon. While there, McConnell specialized in legal phases of government regulation of corporate enterprises and had as a major client the RCA Manufacturing Company, Inc. A post with the Camden, New Jersey, company's legal department was accepted by McConnell in 1941, and within a year he was named General Counsel of that organization. Three years later he was elected Vice President and General Attorney of the division and in 1947 was named Vice President Law and Finance. In 1949, he was appointed Vice President Finance of the parent company, RCA.

On October 7, 1949, Niles Trammell resigned as President of the National Broadcasting Company (NBC) to become Chairman of its board of directors, succeeding David Sarnoff. The board elected McConnell to fill the vacancy of President.

Early in McConnell's presidency, NBC was realigned as three major divisions: one for the radio network, one for the television network, and one for the six radio and five television stations which the company owned and operated. The executive and administrative corps of the company was also enlarged by the addition of a number of executives from advertising agencies and allied industries to augment the advertising and programming activities of the broadcasting company. Undertaking a program of expansion for the television network, McConnell supervised the addition of new affiliate stations and the acquisition of several additional studios, among them, the Center Theatre in New York's Rockefeller Center. With seating capacity of over 3,000, the theater gave NBC possession of the largest television studio in the United States at that time, having such facilities as a stage of 4,200 square feet with a revolving center section, a particular advantage given the rapid scenery changes demanded by the medium.

As the result of an agreement signed by McConnell on January 23, 1950, NBC agreed to relinquish its exclusive rights (held for 18 years) to use the top of the Empire State Building for radio and television transmission. The company gave up its rights in order to allow for the building owners' construction of a steel mast to support the antennas of four television transmitters. The project was hailed by former New York City Mayor William O'Dwyer as an outstanding example of cooperation among the television interests of New York in striving to make that city the nation's television center.

In his first year in office as NBC President (1949-1952), McConnell acted as spokesman for the television industry at a meeting with the National Collegiate Athletic Association, which was considering barring television from its games. Comparing the situation to the early days of radio, when colleges banned football broadcasts, McConnell pointed out that in 1949 attendance at televised college football games had risen four percent while non-televised professional games dropped 9 percent. On behalf of the television industry, he offered to finance a survey of the effects of TV on sports box-office receipts.

McConnell also believed that television's growth did not signal the demise of radio. In 1950, he signed an agreement for RCA to provide the financial backing for the Broadway musical *Call Me Madam* in return for radio, television, and cast album recording rights. The agreement was viewed as a historic marriage between radio and the theater.

In 1955, McConnell joined Reynolds Metals as General Counsel. He became a Director in 1955 and Executive Vice President in 1959. He served as President and Chief Administrative Officer from February 1963 until his retirement on June 1, 1971. In 1963, McConnell also served, with the rank of Ambassador, as Chairman of the U.S. Delegation to the Extraordinary Administrative Radio Conference held in Geneva, Switzerland. This conference resulted in the international treaty which established the frequencies on which various countries would broadcast via satellite. McConnell became a Director of COMSAT in 1969 and served as Chairman of the Board from 1970 to 1979. He is currently Chairman Emeritus of the COMSAT Board of Directors.

u contributed by Diana L. Hollenbeck

MCI Communications Corporation (MCI)

An international telecommunications company that provides voice, data and private line telecommunications services to both business and residential customers. It is the second largest carrier of voice traffic in the United States and the fifth largest international carrier.

MCI, Inc., originally named Microwave Communications, Inc., was founded in 1963 by John Goeken. His goal was to build a microwave radio system between St. Louis and Chicago for his mobile (two-way) radio company. At the time, American Telephone and Telegraph (AT&T) had exclusive rights for any telecommunications transmission. Goeken sought approval for his system from the Federal Communications Commission (FCC). In 1966, the FCC decreed that MCI could conduct business. However, it did not indicate that MCI could expand or connect to any of the regional Bell operating companies. A turning point in the company's operation came in 1972 when it filed an appeal and AT&T rescinded its legal arguments. MCI then began providing long-distance telephone service.

By 1973, MCI had expanded its network to 40 U.S. cities. However, it wasn't until 1974, when the company was awarded an unprecedented $1.8 billion dollars in its landmark lawsuit charging AT&T with monopolization, that its continental expansion began. Today, MCI has offices in more than 55 countries.

A unique marketing strategy used by MCI is its customized calling plans, such as "Friends and Family," which offers residential MCI customers a discount on calls to other designated MCI subscribers. MCI's customized calling plans were made possible by the company's investment in digital enhancements and computer systems, which total more than $10 billion. By 1991, in fact, MCI's nationwide network was completely digital.

Company Chairman William McGowan retired from the organization in 1991 and died in 1992. Bert C. Roberts, who joined the company in 1972, succeeded him as CEO in 1991. Roberts was named Chairman of the company in 1992.

Noteworthy about MCI's international expansion is its 1993 agreement with British Telecom, which agreed to buy 20% of the company and entered into a joint venture to market MCI communications services around the world. In 1994, MCI forged an agreement with Grupo Financiero Banamex-Accival of Mexico. MCI will own 45% of the business with its newest international partner.

Other divisions of MCI include Western Union International, a teletext provider; Satellite Business Systems, a satellite-transmission-based long-distance carrier; and RCA Global Communications, a service that provides data communications. Among other acquisitions, MCI also purchased Telecom USA (in 1990). This division will work with British Telecom to build transatlantic fiber optic cable.

Today, MCI's annual revenues are in excess of $13.3 billion. It has more than 37,000 employees around the world.

u contributed by Valerie Switzer

Roberts, Bert C., Jr. (1942 –   )

American telecommunications company executive, electrical engineer, marketing strategist, and Chairman of MCI Communications Corporation. With both an engineering and marketing background, Roberts has led MCI to second place in the very competitive domestic long-distance carrier industry.

A native of Kansas City, Missouri, Bert Roberts grew up in the midwest. He attended the Johns Hopkins University in Baltimore, where he earned a BS in electrical engineering.

Roberts began his career in 1960 at Westinghouse Electric Company. From 1960 until joining MCI in 1972, he was with Leasco Response, Inc., a computer time-sharing firm. He joined MCI's sales and marketing department after leaving Leasco. Since that time, he has served in a variety of senior management positions that include responsibilities in almost all areas of MCI's operations. In 1985, he was named President and Chief Operating Officer of MCI, and was appointed Chief Executive Officer in 1991.

For two consecutive years, in 1990 and 1991, Roberts was named one of the top telecommunications executives by *Telephony.* In the same year, he was named a telecommunications network visionary by *Communications Week.* In 1993, he was selected by *Advertising Age* magazine as Adman of the Year.

In awarding Bert Roberts its prestigious honor as "Adman of the Year," *Ad Age* noted that Roberts has been at MCI since the early decision to position MCI as a major player in the competitive long-distance carrier business. From the beginning, Roberts worked closely with former MCI Chairman William G. McGowan. He learned all aspects of the business and was especially interested in the MCI marketing efforts. When he received the Adman of the Year award, Roberts noted that MCI's consumer marketing plans had been 20 years in the making.

With the debut of the company's advertising in 1984, the initial thrust was to broadly target business and consumer long-distance customers with discounted rates. Then, after weathering a difficult time on Wall Street in the late 1980's and the recession of the early 1990's, MCI began gaining market share and has been doing so ever since. It then began strategically targeting its marketing segments in 1991. A major component of its success has been its packaged long-distance discount programs, like "Friends and Family" and "1-800-COLLECT." MCI's successful advertising campaigns of the early 1990's have helped move the organization to the number two position in market share and have put rival AT&T on the defense.

Among other awards, Roberts was appointed to serve on the Department of Commerce's National Information Infrastructure Advisory Council. The Advisory Board offers advice to the current administration on telecommunications policies to encourage the development of the information superhighway. He also is a member of the President's National Security Telecommunications Advisory Council (NSTAC). Through MCI's 1993 joint venture with British Telecom, Roberts also is now a member of British Telecom's Board of Directors. And, in July 1995, he joined the Board of Directors of News

Corporation, after MCI bought a twenty percent share and formed an online joint venture with the global media company.

With MCI’s future plans of continuing its international long-distance expansion and its positioning to be part of the new media, it seems certain that Bert Roberts will continue in his leadership role at MCI.

u contributed by Valerie Switzer

Mind Extension University (ME/U): The Education Network

Mind Extension University (ME/U) provides personal enrichment, professional development and academic programming for credit on cable television and is the only 24-hour network devoted to education and learning. ME/U was launched in 1987 by parent Jones International, Ltd. Jones is the senior corporate parent of more than 20 subsidiaries in the communications industry, primarily relating to education, electronic publishing, cable television, cable television networks, radio and entertainment.

Glenn Jones, President and CEO of Jones International, Inc., is very interested in how today's technology can enhance lives. According to a recent survey, more than half of Americans are interested in continuing their education. So taking educationally minded programming a step further, Jones launched ME/U to allow students to earn college credit for successfully completed courses. ME/U delivers fully accredited graduate and undergraduate level courses and degree programs via cable. More than 30 of the nation's leading colleges, universities and other distance educators provide the curricula for ME/U. Distance education is the basis of the network. Professors skilled in teaching students at a geographic distance on a regular basis are responsible for successful distance education through ME/U. Regular classes are taped and fed through various means to the distance learners. These students are presented the same content and must meet the same evaluative criteria as on-campus students.

While ME/U offers such things as short courses, certificate courses and personal seminars, the network also has strong academic programming credentials. Undergraduate-level degrees in management, business, social science, hotel and restaurant management, nursing and animal sciences are offered, for example. And on the graduate-degree level, a student can receive a Master of Arts in Education and Human Development with a concentration in Education Technology Leadership or a Master of Arts in Business Communications. ME/U offers a variety of courses from over 30 academic institutions — with ten offering degree programs — and the student doesn't have to leave home to attend.

Once a student is accepted into ME/U, a television schedule is sent to the student, along with appropriate class materials and books. Students are encouraged to tape classes for future reference or to view at a more appropriate time. Assignments and tests are proctored by a university-approved proctor, such as a public librarian or community college testing center, and then mailed to the student's professor. Special situations, such as missing a class or needing direct communication with a professor or general student counseling, are all considered and appropriately addressed by the ME/U staff. In fact, interaction from student to teacher via voice mail or electronic bulletin board is an integral part of this distance education methodology. And for those individuals whose local cable systems don't yet carry the free ME/U service among their basic cable offerings, a videotape course option is available.

Non-credit classes in adult literacy, computers, languages, business communications, learning strategies, foreign language and computer skills are also available on ME/U. Plans for additional classes in parenting and child-care are underway.

Whether a student is of ‘student age’ or beyond with job and family responsibilities, ME/U offers everyone an equal chance at furthering their education and pursuing intellectual stimulation. Founder Glenn Jones believes that everyone is a lifelong learner and says, “Mind Extension University’s purpose is to create a great school…an electronic campus that is filled with excitement and that makes educational opportunities available to everyone…regardless of where you live…who you are...your position in life.” ME/U not only is a great solution to today’s time constraints, but also an excellent way to utilize the medium called television to further one’s education.

u contributed by Michele Messenger

Media Psychology

The study of how individuals react intellectually and emotionally to technology-mediated multimedia environments, such as interactive multimedia computer programs and virtual reality. Exploring the relationship between psychology and technology that results in specific behaviors, media psychology is central to the development of effective instructional technology design. Media psychology is also known as new media psychology and multimedia psychology.

Media psychology is an emerging discipline and a new profession. It has developed with the growing realization that program developers, producers, and designers — as well as society at large — need a better understanding of how multimedia elements, singly and together, affect people's intellectual and emotional responses. For developers of interactive multimedia computer software and instructional courseware, media psychology encompasses a broad span of considerations. These range from an understanding of the perceptions, emotions, understandings and behaviors the developer wishes to achieve to an understanding of theories of intelligence, learning, communication, and cognition.

Media Psychology and Interactive Media Choices
Technical breakthroughs now allow enormous amounts of data to be placed on a single 4.7-inch compact disc. A standard disc can hold over 600 megabytes of data although this is quickly gobbled up by the rich imagery and sound of today's products. Assembling a multimedia program requires a variety of layout techniques and choices to manage the bit geography on the surface of a disc. Although most title developers are knowledgeable about what the technical choices are, few understand the cognitive and emotional impacts resulting from their choices.

The size of the disc is not the only constraint. Much of what we experience in a CD-ROM application is bound by the delivery rate from the CD drive, just as the quality of a cable TV or radio program is limited by signal bandwidth. The difference is that on a CD-ROM, the designer decides how much of the available bandwidth will go to various components: sound, images, and data. For sound, the amount of disc space and the bandwidth attributable to audio will affect, respectively, the total length and the quality of the sound on a product. At the highest fidelity audio used for music CDs (16 bit, 44 kHz), a designer can barely fit 72 minutes on a disc. By lowering sample rates and using various compression schemes, a designer can get over 19 hours of sound on a disc. The impact that the audio quality choice has on the cognition and experience of the user is what has to be decided for each sound byte.

For images, a designer may choose a color palette with as little as two color choices (1-bit) to as many as 16 million color choices (24-bit); the typical application uses a palette of 256 colors (8-bit). Each variation in the number of colors uses greater or smaller amounts of space on the disc surface, so decisions about color images are controlled and managed by the amount of real estate available on the disc and the delivery rate (bandwidth) needed. Again, what impact the color image decision will have on the cognitive or emotional experience of the user is a question that media psychologists are just beginning to explore.

Decisions about sound and image qualities are but several among the myriad choices a designer must make when laying out the architecture of a program. Although designers understand the technical nature of their choices, few are highly knowledgeable about the emotional rationale underlying them.

Fortunately, as new technologies are emerging from the converging industries of computer, cable television, telephony, telecommunications, and education, new lines of exploration and research are also emerging from the disciplines of cognitive science, neuroscience, and social psychology. The lines of inquiry into media psychology deal with the aspects of humanistic and cognitive psychology that relate to the experiences and the results of those experiences that are the outcome of the human-machine interaction, whether it be with a television screen or multimedia PC monitor. Cognitive capacities provide the vehicle through which humans receive, organize, and interpret information. Conscious states enabling experience include: attention and attention span; sensations; perceptions of time, space, and movement; and perceptual and psychovisual illusions. Interactive experiences activate conditions of motivation and emotion and result in thinking, learning, perceiving, conceptualizing, and imagining.

Theories of Multiple Intelligences

Key to exploring the psychological effects of multimedia is an understanding of how individuals think and learn. Emerging theories of intelligence are bringing into question a unified view of intelligence. What is presently recognized, through the work of Harvard Project Zero, Jean Piaget, Howard Gardner, and others, is the nature of varied and multiple human intelligences. In fact, we are largely different from each other because we all have different combinations of intelligences. Along these lines, Project Zero has developed a matrix of seven intelligences: musical, bodily-kinesthetic, logical-mathematical, linguistic, spatial, interpersonal, and intrapersonal. Each form of intelligence may be subdivided or rearranged.

The real point of the question of intelligences here is to simply note that we need to understand the plurality of intellect and that individuals have various intelligence profiles. While the multiple intelligences theory is consistent with empirical evidence, it has not yet been completely subjected to strong experimental tests within psychology. Nevertheless, there are many reasons and much evidence for considering the theory and its ramifications for both learning and the new media.

Learning Psychology

The psychology of learning encompasses all forms of relatively permanent behavior changes and is concerned with improving the effectiveness of learning. It includes theories of intelligence, theories of learning, and media and learning. Understanding the elements of how and why people learn has revealed the effectiveness of media in learning. Growing appreciation of this reality, plus the advances in technology noted earlier, give rise to expansion and momentum in distance learning and the use of media in teaching.

With respect to learning as a skill, strategies for learning and for understanding *how* to learn now give rise to distance learning and learning on demand. The realization that knowledge is portable, pliable, and can be transmitted via the airwaves is fundamental to the growing interest in distance learning opportunities worldwide. The increasing public interest in distance learning and the new technology developments mean that this window of opportunity is now opening for education.

Luskin's Three-S Model: Elements of Media Psychology

The concept of media psychology is a composite of the various conditions described in the context of three key areas: semantics, semiotics, and synesthetics. *Semantics*, the study of meaning in language, is central to our ability to understand words which are fundamental to the behaviors of interaction. A simple example is the use of the word quit. Quit, a pejorative term of frustration meaning to give up, is a software programming term that has found its way into many computer products. The subliminal response to the word quit is negative. Better choices would be end or stop since they convey the appropriate meaning without the implication of failure the word quit conveys.

Semiotics, the study of signs and symbols in human communication, plays an important role because visual symbol manipulation facilitates the human-machine interface. It creates a relationship. It enables navigation and control over media pathways. Clear, creative, and careful use of symbols is giving rise to iconography as a highly developed skill. The graphical interface, through which on-screen information is made accessible, is the principal point of contact between machine and man.

Synesthetics is the study of how diverse stimuli received by one sense engage a response from another sense. It is perhaps the line of research most critical to the development of media psychology's emotional dimension. In the new media, our total environment is a multi-sensory response to various audio visual elements.

Synesthetics coupled with television or computer interaction creates sensory rivalry and may create positive or negative experiences or reactions. One stimulus may create a positive reaction — others may create conflicts of cues or sensory rivalry. The result, in any case, is synesthetic and is essentially the experience resulting from the union of senses and media. Examples of such experiences include seeing a boat rocked by waves, which may activate a sense of imbalance in an observer to the extent that it causes seasickness; viewing a painting of an Arctic scene of frost and snow, which may evoke the sensation of icy cold, producing goose bumps; hearing an explosion or gunshots, which may give one the illusion of being struck; or looking at a picture of appetizing food, which may evoke sensations of taste and smell. Each of these examples represents a potential behavioral or psychovisual result engendered by a media interaction, coupled with various unions between and among the senses.

Importance of Media Psychology

As a society we have studied aspects of media psychology for a century in art, literature, motion pictures, and now, interactive multimedia. Historically, we have examined the role of mass media communications and entertainment. Much of the focus has, understandably, been devoted to the issue of violence in media, a concern heightened by both increasing violence in motion pictures and the disturbing, increasingly graphic bloody video games. Although those who wish to defend programs with high levels of violence deny that the programming has any significant effect on behavior, report after report, year after year, reaffirms the desensitizing effects of repeated exposures and the absolute effect of such exposures on behavior. Clearly, what is seen, heard, and interactively — if vicariously — participated in, influences behavior. The exploration of media psychology will increase our understanding of the effects of interactive media, learning, experiences, and behavior. Through media psychology, we can learn to use video, sound, print, and their critical components interactively to involve individuals in learning, positive growth and personal achievement and self-actualizing experiences.

The digital explosion, so far, has been primarily a technology drama. Consumer electronic companies, regional Bell operating companies (RBOCs) and other telecommunications companies, computer companies, print publishers, media conglomerates, and budding software developers are continuing to invest literally hundreds of millions of dollars in the technology, i.e. the how. To the present, very little has been carefully invested in the why of interactive program creation. Media psychologists are now exploring the why, creating a new discipline within which to structure our converging research.

u contributed by Bernard J. Luskin

Minow, Newton Norman (1926 –)

Attorney, professor, author, corporate board member, and former Chairman of the Federal Communications Commission (FCC). One of the most famous of the former FCC chairmen, Newton Minow is best known for his address to the National Association of Broadcasters on May 9, 1961, in which he called television a "vast wasteland."

Newton Norman Minow was born in Milwaukee, Wisconsin, on January 17, 1926. He married Josephine Baskin on May 29, 1949. That year, he earned a BA degree from Northwestern University in Evanston, Illinois. In 1950, he received his law degree from Northwestern.

He began practicing law in 1950 with the law firm of Mayer, Meyer, Austrian & Platt in Chicago. In 1951, he was appointed law clerk to the Chief Justice of the United States, Fred M. Vinson. In 1952, he was named Administrative Assistant to Illinois Governor Adlai Stevenson and served as Special Assistant during Stevenson's 1952 presidential campaign. In 1953, he joined Stevenson's law firm, Stevenson, Rifkin & Wirtz as a partner. Minow continued in his role as Special Assistant during Stevenson's unsuccessful 1956 presidential bid as well. Returning to law after the campaign, Minow continued with Stevenson, Rifkin & Wirtz from 1957 to 1961, working in New York City and Washington, D.C., as well as Chicago.

In 1961, Minow was appointed Chairman of the Federal Communications Commission by President John F. Kennedy. Shortly after his appointment, Minow shocked the broadcasting industry with his address to the 39th annual convention of the National Association of Broadcasters in Washington, D.C. On May 9, 1961, in his remarks, he paraphrased the famous poem by T. S. Eliot, *The Waste Land,* and added "vast" to the well-known title. He warned broadcasters that license renewal was not automatic and cautioned his audience about inappropriate and reckless use of the public airwaves. He noted that a broadcasting license, "…lets you use the public airwaves as trustees for 180 million Americans…If you want to stay on as trustees, you must deliver a decent return to the public."

Having captured the attention of his audience, he assumed the part of an American television viewer and urged members of the audience "to sit down in front of your television… I can assure you that you will observe a vast wasteland. You will see a procession of game shows, violence, audience-participation shows, formula comedies about totally unbelievable families, blood and thunder, mayhem, violence, sadism, murder, Western bad men, Western good men, private eyes, gangsters, more violence and cartoons. And, endlessly, commercials — many screaming, cajoling, and offending."

He continued by reminding his audience once again that broadcasters using publicly owned airwaves must be mindful of the service they owe the American viewing public. He alerted his audience by stating, "Renewal will not be *pro forma* in the future. There is nothing permanent or sacred about a broadcaster's license."

Trade publications, including *Broadcasting* magazine, reported that Minow's speech left those attending "stunned and indignant." However, published reports indicate that members of the American television viewing audience were in agreement with Minow. The FCC reported that it received more than 4,000 letters in response to the speech. Of that total, approximately 100 took exception with Minow's views.

Minow seemed earnest about wanting to improve the quality of television programming. However, he resigned from the FCC after serving as Chairman for two years. After the death of President Kennedy in 1963, Lyndon Johnson became President. Because a sizable amount of the personal wealth that President Johnson had amassed came from the commercial television station he owned in Austin, Texas, he brought a much more sympathetic perspective of broadcasting to the White House. As it turned out, very few of the many stations making application to renew their licenses were denied renewal during Minow's tenure. What was unusual about his Chairmanship was his support from the press and ultimately the public at large.

Following his resignation from the FCC in 1963, Minow was named Executive Vice President, General Counsel and Director of Encyclopedia Britannica, based in Chicago. In 1965, he became senior partner in the Chicago law firm of Liebman, Williams, Bennett, Baird & Minow (now Sidley & Austin), He was elected Chairman of the Board of the Rand Corporation and Chairman of the Chicago Educational Commission, and Chairman of the Public Broadcasting Service (PBS). In addition, he served on the board of directors of Foote, Cone & Belding, a well-known advertising agency, and on the board of CBS and the Tribune Company.

Minow also sat on the boards of directors for Chicago Pacific Corporation, the Carnegie Corporation of New York (where he was elected Chairman in 1993), Sara Lee Corporation, AON Corporation and Manpower.

His career has also included time spent as a Professor of Communications Law at Northwestern University. In 1986, he was a Visiting Fellow for the John F. Kennedy School of Government at Harvard University. In addition, he became a Director for the Annenberg Washington Program in Communications Policy Studies of Northwestern University in 1987.

Minow wrote *Equal Time: The Private Broadcasters and The Public Interest* in 1964 and co-authored *Presidential Television* in 1973. A third book, *Electronics and the Future,* was published in 1977, along with *For Great Debates,* his fourth book. In addition, he was a contributing writer to *As We Knew Adlai*. In 1995, Minow and Craig LaMay published *Abandoned in the Wasteland: Children, Television and the First Amendment*.

Newton Minow has received a number of awards throughout his career. In 1961, he was named one of America's 10 Outstanding Young Men and was awarded the George Foster Peabody Broadcasting Award. In 1978, he received Northwestern University's Alumni Medal. In addition, he was named a Trustee for Notre Dame University and the Mayo Foundation and is a Life Trustee of Northwestern University. In 1982, he received the Ralph Lowell Award. He is a Fellow of the American Bar Foundation. He has received nine honorary doctorate degrees.

Minow and his wife have three grown daughters, Nell, Martha and Mary.

u contributed by Valerie Switzer

Modem

An acronym derived from MODulator/DEModulator. A modem acts as a bridge between analog and digital signals. Computers save information in a digital code. Telephone systems transmit information in analog form, as a series of electronic currents that vary in frequency and strength. A modem translates data from digital to analog form and vice versa, thus facilitating communications between computers (digital) via the phone lines (analog).

Many users connect to the Internet and on-line services using a computer and phone lines. Unfortunately, computers and telephones communicate in completely different ways. A computer's memory is made up of binary code, represented as a series of zeros and ones. Unlike telephone lines, which send out continuous electronic currents that vary in strength and frequency, a computer is either sending information or is in an inactive mode. There is no in-between.

For these two different types of communication devices to work together, they need a device that converts digital signals to analog and vice versa. This is accomplished by a process known as MODulating/DEModulating, hence the device name: modem.

Hayes-Communication Protocol
Modems involve the use of several layers of computer interfacing. Most personal computer modems follow the Hayes-communication protocol, which connects to the computer at a 25-pin serial port. Hayes, one of the first modem manufacturers, created a communications command language that is still popular today. First, the communication software must make sure that both the computer and modem are turned on and ready to transmit data. It does this by sending voltage along pin 20 of the serial port. This voltage, called the Data Terminal Ready signal (DTR), tells the modem that the computer is on and ready to begin transmission. At the same time, the computer receives voltage on pin 6, called the Data Set Ready (DSR) signal. This lets the computer know that its modem is ready. Unless both signals are received, the communications package will not proceed.

After the communications package has run its signal check, it sends a command to the modem on the transmit data line. This tells the modem to open a connection with the telephone line. The Hayes command package tells the modem to dial out to a predetermined phone number; the modem then replies back on the receive data line.

The phone call connects the first modem placing the call to another modem on the other end of the connection. The first modem sends out a hailing tone to the remote modem, which responds with a set of higher-pitched tones. After connection is established, the modems exchange information on how they will transmit the data. This process is known as a handshake. It includes how fast data will be transmitted, the number of bits in a data packet, how the modems will check for errors, and whether they will use half duplex or full duplex. If the two modems cannot come to an agreement, transmission will end.

The handshake is made up of a variety of elements. Transmission speed is usually expressed as a baud rate, which stands for the number of frequency changes occurring in one second. Baud rates can go from 300 bits per second on old modems to 28,800 bits per second in the most current models. Data packets are bits that signal the beginning and end of a packet. Most communication systems use seven or eight bits to represent the packet. The start/stop bit uses one or two bytes to signal the end of a character. Parity bits make sure that the computer recognizes errors in transmission. Finally, half duplex and full duplex make sure that the two modems know which is responsible for displaying transmitted data. In full duplex, the information is shown on both terminals, while in half duplex, the system echoes the data being sent.

After the modems agree on how transmission will take place, the communication software begins to send the data. It sends a signal to the fourth prong of the serial port. The signal is called the Request to Send (RTS). If busy doing something else, the computer will tell the modem to stop the RTS signal until it is free again. Once the processor is ready, it sends out a Clear to Send (CTS) signal on line 5. It sends data to the remote system on line 2 and receives incoming data on line 3.

Both modems can send information out at the same time, due to distinguishing tone patterns. The modems hear incoming data as a series of tones with different frequencies and then demodulate the tones upon receipt back to digital form.

Finally, the user tells the communications software to end transmission. To do this, the software sends another Hayes command to the local modem to disconnect the phone line. If disconnection happens on the remote computer, the communications package lets the user know that the link has been broken.

Modern Modem Features

Modems can be located either inside or outside of the computer. Many newer modems are already equipped with a second set of communications software that allows them to accept and send fax transmissions. This software may also contain elements of optical character recognition (OCR) that allow the import of graphics as well as text files.

As the need for transmission grows, so will the speed, or baud rate, of modems. When modems first came on the market, they transmitted at less than 300 bits per second. Now, average transmission rates run between 14,000 and 28,000 bits per second — and the speed is likely to increase from there.

Unfortunately, the modem industry has been built with minimal standards, or rules for operation. As a result, many communications software packages and modems fail to work properly with each other. This means failed communications and higher error rates in transmission. The Hayes-communication command codes remain the most popular, but several other companies have tried to develop their own standards.

Eventually, all computer users may be able to connect directly via integrated services digital network (ISDN) or other digital interface into a network, bypassing modems altogether. This would increase transmission rate and severely reduce the amount of errors. Unfortunately, this is still an expensive and hard-to-obtain computer option. Until it becomes widely available, computer users will need modems to connect with outside networks.

u contributed by JDC Editorial Staff

Modified Final Judgment

An agreement reached by the U.S. Department of Justice (DOJ) and American Telephone & Telegraph (AT&T) on January 8, 1982, that settled a ten-year antitrust lawsuit and broke up the Bell System monopoly on telephone service. AT&T kept its longdistance business, as well as the core businesses of Bell Laboratories (Bell Labs) and Western Electric, and was given the right to enter noncarrier lines of business, specifically the computer arena. The 22 Bell operating companies were recombined into seven independent regional Bell operating companies (RBOCs) to provide the remaining regulated parts of the telephone business, primarily local telephone service and access to long-distance carriers.

The Modified Final Judgment (MFJ) was the culmination of more than a decade of antitrust wrangling that basically started in 1969. That year, the Federal Communications Commission (FCC) granted Microwave Communications Inc. (MCI) an application to provide intercity private-line services between Chicago and St. Louis using microwave transmissions. The chairman of MCI, William McGowan, intended to break up the Bell System monopoly and began by competing for very limited private-line traffic. McGowan and many others felt that the advent of new technologies, including microwave radio and satellite systems, made competition not only possible but desirable. In 1971, following increasing pressure from MCI, the FCC expanded the original, limited MCI decision to allow all specialized common carriers, not just MCI, to interconnect to the Bell local networks nationwide.

But that was only the beginning. Feeling the time was right to really push the competition issue, MCI filed an antitrust suit against AT&T in March 1994. Later that same year, the DOJ followed with its own antitrust suit, charging the Bell System with illegally restricting competition and monopolizing the marketplace. The DOJ’s stated purpose was the breakup of the Bell System.

After several years of AT&T contesting the antitrust action, the case went to trial in March 1981 under District Judge Harold Greene. As the DOJ presented its case, AT&T realized it was fighting a battle it couldn’t win and the only way to have a say in its own future was to negotiate a settlement. On January 8, 1982, the two parties announced their settlement in the form of the Modification of Final Judgment (or Modified Final Judgment as it is more commonly known). In so doing, the course of the telephone industry was drastically changed.

AT&T kept its long-distance operations, but was now subject to open competition for the long-distance market. In addition, it was allowed to keep its manufacturing branch, Western Electric, and its research branch, Bell Laboratories. AT&T also was now allowed to move into other nonregulated businesses, such as computers.

Local telephone service was to remain under seven independent RBOCs known as Ameritech, Bell Atlantic, BellSouth, NYNEX, Pacific Telesis, Southwestern Bell Corporation (now SBC Communications), and U S WEST. These companies could provide all aspects of the telephone business except over-the-phone information or video services, phone equipment manufacturing, and long-distance telephone service. They also retained the Bell logo, Yellow Pages publishing, and all in-place customer equipment.

AT&T was given two years to prepare for the breakup, and on January 1, 1984 the end of the Bell System monopoly was official.

In the ten years since the MFJ went into effect, new challenges have arisen to its validity; but this time, they're coming from the other direction. The still-regulated RBOCs claim that the MFJ's restrictions are preventing them from competing fully in the telephone industry. They are pushing for new legislation that would set aside many MFJ provisions and fully open the telephone business to competition. They already have been successful in getting the courts to modify the MFJ to allow the RBOCs into the information services industry. And it appears that before the turn of the century, the MFJ will be obsolete and the RBOCs will be able to compete fully in the telecommunications marketplace.

u contributed by Linda Stranahan

Editor's Notes:
Judge Harold Greene has been asked by the Justice Department to eliminate the Modified Final Judgment of 1982. The Telecommunications Act of 1996 provides new guidelines for telecommunications regulation, and the Department of Justice believes that Judge Greene's involvement with the issue is no longer necessary.

Modulation

Changing the frequency or amplitude of a radio frequency by the addition of an electrical signal that contains the voice or picture information.

Both radio frequencies and sound waves have frequency and amplitude. Frequency is the number of waves that pass a point in one second. Amplitude is the strength of the wave, which for sound is the volume and for television pictures is the brightness. Sound waves, even those that are amplified, are audible for relatively short distances.

To transmit sound, the sound wave is first converted to an electrical signal by an electronic device, such as a microphone. The electrical signal is then used to create changes in, or modulate, a carrier wave. The carrier wave is a constant, high-frequency electromagnetic wave. Quartz crystals are often used as oscillators, or sources of carrier waves, because when they are stimulated they put out stable, high-frequency waves. The shape and size of the crystal determine the frequency of the carrier wave it generates. The frequency that is generated by the crystal is amplified before it is used as a carrier wave.

In a *frequency modulated* (FM) signal, the frequency of the carrier wave is modulated, going from higher to lower frequency as the electrical signal changes. In an *amplitude modulated* (AM) signal, the amplitude of the carrier wave is modulated from higher to lower as the electrical signal changes.

Modulation of a Television Signal
To transmit pictures, a television camera converts the images into two electrical signals. The first signal is the luminance, which is the brightness of the picture. Luminance ranges from a maximum voltage that produces white, down to the lowest voltage that produces black. The second signal is chrominance, which is the color of the picture elements. Color is carried on the *color subcarrier*.

A television signal is 6 MHz wide and is divided into three bands. The audio band is .25 MHz below the upper frequency boundary. The video band is 4.2 MHz wide and includes the color subcarrier, which is 3.58 MHz above the picture carrier. Guard bands, which separate each television channel from those around it, make up the remainder of the 6 MHz band.

By combining the luminance and chrominance, a television set displays a full range of colors at varying degrees of brightness; and when two audio sources are included in the signal, the television can provide stereo sound.

To transmit stereo sound, a separate subcarrier is used to carry the signal from a second audio source, which is normally another microphone. The second audio source modulates the subcarrier, which is then superimposed on the main signal so they can be transmitted simultaneously. Since the carrier and subcarrier are on different frequencies, they do not interfere with each other.

Demodulation

Once a carrier wave, including any subcarriers, is modulated, it can be transmitted by wire, cable, or broadcast through the air. In broadcast television and radio communications, the receiver *demodulates* the signal. Demodulation is the process of removing the carrier wave. Since a signal is transmitted on a carrier wave that has a constant frequency center (for example, 107.5 MHz for an FM radio station) the receiver strips that frequency away from the incoming signal. What remains after the carrier wave is removed is the original electrical signal that came from the microphone. This electrical signal is then converted into sound by speakers.

Changing Television Signals
In cable television, the signal is received at the headend of the cable system. Here, some of the incoming signals are demodulated and *remodulated* at the same frequency, and some are demodulated and remodulated at a different frequency. Remodulation means that after demodulating the incoming signal (converting it to an electrical signal), that electrical signal is used to generate a new carrier wave with a different center frequency. Remodulation is often done to television signals that are received by microwave. For example: a microwave signal received from a satellite at channel 24 could be remodulated at channel 14 so it fits into the channel lineup.

Broadcast signals that are received at the headend of the cable system are changed from one frequency to another in a process called *heterodyning.* When a signal is changed by heterodyning, the frequency is changed without altering the video and audio signals. For example: a local signal could be broadcast at channel 4, then the frequency changed to channel 5.

Specialized Modulation
Amplitude modulation and frequency modulation are the most common types of modulation; however, there are several ways to modulate carrier waves used in specialized electronic communications.

One type of modulation that is common in telephony is *pulse code modulation* (PCM). PCM is a way to transmit an analog signal (for example, the sound wave of a voice) on a digital system.

In PCM, the amplitude of the sound is checked at a rate two times the signal's highest frequency. Since voice signals carried by phone are frequently limited to 4,000 Hz, in PCM the signal is sampled 8,000 times each second. This sampling process is called pulse amplitude modulation (PAM). The PAM results are converted into binary numbers made up of a series of ones and zeros. Each of the eight bit binary numbers represents the value of the amplitude at the time each PAM sample was taken. The digital representation of the voice can be transmitted, demodulated by the receiver, and the sound recreated as sound waves that can be heard.

A carrier wave contains no information until it is modulated. The ability to modulate a carrier wave with the signal that contains the message, either voice or picture, makes possible electronic communication between distant people and machines.

u contributed by Paul Stranahan

Morse Code

A method of communication used to transmit messages over long distances. It was developed by portrait painter and inventor Samuel F. B. Morse in 1836. His original intent was for the U.S. government to use it to send secret and important messages via the electromagnetic telegraph which he also invented.

Morse code was invented by Samuel Finley Breese Morse in 1836 as a means of electronically transmitting messages. It is comprised of a series of dots and dashes used in combination to represent letters, numbers and punctuation. By using a simple sounding key on his first telegraph system, Morse could send electromagnetic impulses, either a short (dot) signal or long (dash) signal, that were printed by moving a pencil on a thin strip of paper on Morse's receiver. This code, sent in a variety of combinations, including pauses, represents letters of the alphabet. The pause between each letter or number unit (character) is made up of the time equal to three dots. The pause between each word is equal to six dots.

Although the first Morse code was a printed signaling system, Morse realized early on that it could also be used as an auditory system. Radio telegraphy, which became the more prevalent means of transmission, was launched in 1897. It uses a buzzer in place of the printer. Morse code is also transmitted between ships at sea by means of a signaling lamp that uses flashes of light.

Morse's first telegraph, which he devised in 1836, would only work as far as 40 feet from the battery that powered it. Morse sought advice from Dr. Leonard Dunnell Gale, a professor of geology and mineralogy at New York University, about further developing his telegraph. Dr. Gale agreed to help Morse in return for a portion of the patent and the profits. They tried winding wire around Gale's classroom until they were able to send messages as far as ten miles. Morse then developed a system of electromagnetic relays. This allowed him to send messages over any distance.

In order to build a more efficient telegraph, however, Morse needed more assistance. At this point, he enlisted the help of Alfred Vail, a former student at New York University who was a skilled mechanic, having perfected his trade by working in his father's ironworks. In exchange for one-quarter ownership of the patent, Vail agreed to work on Morse's new invention. He not only agreed to invest his own time and his father's money in the project, but he also signed a contract which gave Morse three-fourths ownership of any inventions Vail might produce. (Vail retained one-fourth ownership.) The second version of the telegraph, reportedly built largely by Vail, was more efficient and durable than the original.

Having successfully invented both the telegraph and Morse code, Morse then went to Washington, D.C., to apply for patents from the U.S. government and to seek funds to help further advance his inventions. It took several years of effort. However, in March 1843, Congress finally approved a $30,000 grant for Morse. Once he received funding, he installed a 44-mile link of telegraph wire from a Supreme Court office in Washington to the train depot in Baltimore, Maryland. On May 24, 1844, Samuel Morse made history.

Using his own Morse code of dots and dashes, he sent the now-famous message, “What hath God wrought!”

Morse code and the telegraph had an immediate impact on the United States and the rest of the world. In fact, the Associated Press’s decision to use the telegraph was an important key to the telegraph’s rapid acceptance in the United States. In addition to first Morse code (Early Morse), two other versions evolved, American Morse and International Morse. International Morse code is still in use today.

u contributed by Valerie Switzer

Morse, Samuel Finley Breese (1791-1872)

American artist and inventor, known during his lifetime for painting fine portraits of the day's prominent men, but now famous for developing the electric telegraph.

Samuel Morse was born in Charlestown, Massachusetts, in 1791. He was educated at Phillips Academy, Andover and Yale University, where he exhibited a keen personal interest in the diverse subjects of portrait painting and electricity. He graduated from Yale in 1810 and his parents sent him to London the next year to study art, his chief passion.

He returned to the United States in 1815, began painting portraits for a living, married Lucretia Pickering Walker in 1819, and eventually became a leader among New York City's artists and intellectuals. His friends included novelist James Fenimore Cooper and the Marquis de Lafayette, French hero of the American Revolution. Two of Morse's most successful portraits were of General Lafayette, whom he painted in 1825. His wife died at childbirth that year and his three children were sent to live with relatives. From 1826 to 1845, Morse served as President of the National Academy of Design, which he helped found.

While aboard a ship returning from Europe in 1832, Morse first conceived the idea of the electric telegraph. Basically, its concept involved an electric current working an electromagnet, which in turn caused a pencil to mark a moving strip of paper in a series of dots and dashes. During the mid-1830's, Morse taught art at New York University where he also continued work on his invention. By 1837, he was totally immersed in making the telegraph a reality, along with several partners including Alfred Vail.

Morse applied for the U.S. patent that year and began seeking domestic and foreign aid for his invention as Alfred Vail worked to perfect it. In 1838, the telegraph instruments finally worked to the relief of all and Morse and Vail began exhibiting their new invention to the public.

In 1844, the first experimental telegraph line was built from Baltimore to Washington, D.C., with $30,000 support from the U.S. Congress. Morse oversaw the project as Superintendent of Telegraphs, with Alfred Vail assisting as usual. The first message transmitted over those 44 miles of wire in Morse Code to Vail was: "What hath God wrought!"

For the next 10 years, Morse was enmeshed in a number of legal battles with his partners and rival inventors. But the U.S. Supreme Court finally awarded Morse the patent rights in 1854, bringing him wealth and honors during his remaining years. He died in 1872 in New York City, a successful painter, philanthropist, patriarch and credited with invention of the telegraph.

u contributed by Kay S. Volkema

Motorola, Inc.

American high-tech company that has pioneered car radio, semiconductor, pager and cellular phone technologies. Motorola is well-known for its contributions to technology; its commitment to affordable, high quality products; and its business foresight. The company is headquartered in Schaumburg, Illinois.

One of America's most successful high-technology companies, Motorola's sales, service and manufacturing facilities around the globe employ more that 132,000 people. The company pioneered wireless communications technologies and is the world leader in producing pagers and cellular telephone equipment. In addition, the company manufactures semiconductors and advanced electronic systems and services, defense and space electronics, computers and electronic automotive components.

Motorola operates as a vastly decentralized organization adhering to the company's philosophy that internal, as well as external, competition encourages customers' preferences to prevail. Since its founding nearly seven decades ago, the company has built its reputation on three key factors — adaptability, responsiveness and creativity.

In 1928, brothers Joe and Paul Galvin started Galvin Manufacturing — the company that would later become known worldwide as Motorola, Inc. The company's first headquarters was a rented Chicago loft; the first week's payroll was $63; the first product a device that enabled battery-operated home radios to be powered by household electrical current. Soon, the company expanded beyond these battery eliminators and began to produce home radios.

In the early 1930's, both automobiles and radios were increasing in popularity. A marriage between the two was inevitable, but there were significant technical difficulties. For example, cars' electrical systems caused so much static interference that operators were often forced to turn off the engine to be able to hear the radio. Galvin Manufacturing developed an affordable car radio that overcame these shortcomings and featured such innovations as push-button tuning and tone controls. To suggest sound in motion, the product was named Motorola.

By 1937, the company had grown to over 600 employees and introduced its first mobile police radio. This technology would prove invaluable as America was drawn into World War II, and the U.S. Army began searching for ways to support troop communications in the field. Galvin originated a 35-pound backpack radio model (commonly called the walkie-talkie) that was instrumental in monumental battles at places like Guadalcanal, Iwo Jima and Normandy. Other Galvin communication devices for the armed forces included two-way radios for jeeps and tanks. Within a few years following the war, the company had adapted these technologies for commercial use and offered consumers over 100 two-way radio products.

In 1947, Galvin Manufacturing changed its name to Motorola, Inc. By the late 1940's, Motorola had recognized the tremendous potential of the newly developed semiconductor technology and set out to become a volume supplier. Soon the company had opened its first production plant. Within two decades, Motorola was the second largest semiconductor manufacturer in the United States and had built semiconductor plants and sales facilities in various countries including France, Japan and South Korea. Today, the company's constantly improving semiconductor technology is fundamental to many of Motorola's product lines.

Motorola entered the field of television following World War II. Its first model, introduced in 1947, featured a 7-inch tube. *The Motorola TV Hour*, which premiered in 1953, was hosted by Bob Galvin (founder Paul Galvin's son), who promoted Motorola products during commercial breaks. The company developed the rectangular color picture tube, and later, its Quasar transistorized color television revolutionized the industry. In 1974, Motorola sold its Quasar television trademark and production facilities to Matsushita, the Japanese maker of Panasonic products.

By the early 1970's, Motorola had discontinued manufacturing many home electronics products, such as radios and televisions. Instead, the company had dedicated itself to developing new technology-driven communications products. For example, the company had introduced its first radio pager in 1955 — and its first VHF paging system in 1960. Designed for use in large areas, the system could signal any of thousands of pagers on a single radio channel. By the 1970's, Motorola was producing pagers that could receive, display and store messages. A 1981 Motorola pager was selected by *Fortune* magazine was one of the top ten new products of the year. By 1989, when it introduced a wristwatch pager (co-developed with Timex), Motorola had become the only U.S. pager manufacturer.

Motorola was an early participant in the U.S. space program as well. Throughout the evolution of America's space explorations — including the Mercury, Apollo and Voyager programs — the company supplied crucial communications technology. In fact, Motorola equipment enabled the world to see Neil Armstrong descend onto the surface of the moon in 1969 and to hear him say, That's one small step for a man, one giant leap for mankind.

Motorola's DynaTAC system, introduced in the early 1970's, was one of the first wireless telephone systems. Growing consumer demand, however, soon exceeded these systems' capacities. This led to the development of cellular phone technology. Motorola was a pioneer in this area, and by the late 1980's had become the leading worldwide supplier of cellular telephones.

Motorola's first microprocessor — smaller than a postage stamp — contained the capacity of thousands of transistors. Regulating automobile functions was the original major market for this groundbreaking technology — the 1978 Cadillac's trip-mileage computer introduced it to consumers. By the mid-1980's, at least five microprocessors were built into every General Motors car. At the same time, however, auto radios had become a low-technology product, and Motorola opted to discontinue its oldest product. In 1987, the company made its last car radio.

In the 1970's, Motorola foresaw the convergence of the computer and communications technologies. So, in 1977, it acquired Codex Corporation, a leading manufacturer of data communications networks. A year later, Universal Data Systems (UDS), a manufacturer and supplier of equipment such as modems and multiplexers, joined the Motorola family. By the late 1980's, Motorola had become one of the nation's leading suppliers of data communications equipment.

In the area of computer technology, Motorola teamed with IBM and Apple Computer to develop the PowerPC, a high speed microprocessor that is easier and less expensive to produce than other less powerful chips. The company is continuing to develop more advanced technology to keep pace in this rapidly evolving field. The company's new Series 900 computer system — awarded a silver medal by the International Designers Society of America — is a leader in computer modularization. The unique modular system, with its five-year warranty (an industry first), can be easily enhanced as businesses' computing needs evolve.

In 1980, Motorola launched a campaign to challenge its Japanese competitors. This effort was triggered by the company's push to get Nippon Telegraph and Telephone (NTT — the Japanese equivalent of AT&T) as a customer for Motorola pagers. NTT demanded that the company meet its strict quality standards. By 1982, Motorola had succeeded and NTT was ordering its pagers.

Through the NTT experience, Motorola's management recognized that to consistently deliver quality products and services each employee must have superior skills. Today, Motorola requires at least 40 hours of training annually for every employee. Motorola University (headquartered in Schaumburg) has 14 branches worldwide and offers such diverse courses as problem solving, computers and remedial English. In addition, the company has tightened hiring standards. As a result, only one applicant in ten becomes a Motorola employee. In 1988, Motorola was recognized for its outstanding company-wide quality management efforts when the company was named the first winner of the prestigious Malcolm Baldrige National Quality Award.

In 1990, Motorola launched the $3.4 billion Iridium project to create a global communications system using a series of small satellites in low-earth orbit (LEO). The huge initiative — projected to begin commercial service in 1998 — is part of Motorola's long term strategy to develop revolutionary worldwide communications networks that combine satellite communications with today's analog and digital cellular systems.

Under the leadership of CEO Gary L. Tooker, Motorola is continuing the traditions started by the Galvin Brothers. The foundation of this extraordinary company's success remains product and market diversity, advanced technology development and an overriding commitment to quality

u contributed by Susan P. Sanders

Tooker, Gary L. (1939 –)

American business executive currently Vice Chairman and Chief Executive Officer of Motorola, Inc.

Gary Tooker was born in Shelby, Ohio, on May 25, 1939. Following his graduation from high school, Tooker headed west to attend college. In 1962, he received his bachelor of science degree in electrical engineering from Arizona State University (ASU). Later, he pursued postgraduate studies in business administration at ASU.

In 1962, Tooker began his lifelong association with Motorola, Inc. His first position was in the Semiconductor Division. He became Director of Products Operations in 1974, and the following year was named Director of Operations for Discrete Semiconductor Products. Later in 1975, Tooker was promoted to Corporate Vice President and General Manager of the Discrete Semiconductor Division within Motorola's newly created Semiconductor Group.

Continuing his move up the corporate ladder, Tooker was named to head the Semiconductor Group's Discrete Electronic Components Division in 1979. The next year, he was made Vice President and General Manager of the group's International Semiconductor Division, then shortly thereafter was promoted to General Manager of the Semiconductor Products Sector. Tooker was elected as Senior Vice President by Motorola's Board of Directors in late 1982, and became an Executive Vice President in February 1984.

As the computer industry continued to expand, Motorola's successes kept pace. Based on his accomplishments in the various divisions he had led, Tooker was selected Motorola's Chief Operating Officer in 1988 and was made President in 1990. In 1993, Tooker was elected Vice Chairman and Chief Executive Officer. Christopher Galvin, grandson of Motorola's founder, Paul Galvin, holds the company's number two position.

In addition to his responsibilities at Motorola, Tooker is Deputy International President of the Pacific Basin Economic Council and serves as Chairman of its U.S. Member Committee. He also sits on the board of Eaton Corporation. In addition, Tooker is a Director of the National Alliance of Business and Junior Achievement of Chicago, and is active in the Chicago United Way. He is also a member of the Economic Club of Chicago, as well as the Electrical Manufacturers Club.

Previously, Tooker served as Chairman of the Board of Directors of the American Electronic Association. He is also former Chairman of the Semiconductor Industry Association. While living in the Phoenix area, Tooker participated in the Arizona Association of Industries and the Scottsdale Boys Club.

Tooker has continued to be active at his alma mater, serving on the ASU Advisory Council on Engineering, as well as the University's Alumni Associate and Foundation boards. In 1983, Tooker received the Distinguished Alumnus Award from Arizona State University.

u contributed by Susan P. Sanders

Multimedia

The combination of multiple media elements — often including text, video, sound, still images, and graphics — to offer a rich experience of learning and/or entertainment. The term multimedia popularly refers to the innovative, computer-based applications that are now being produced on CD-ROM.

Advances in computing capacity over the past several years — most especially in speed and storage capabilities — have allowed us to move well beyond the rudimentary text-and-number crunching that typified yesterday's computer programs. Simple video games that could be stored on floppy disks pioneered the trend; it was, however, the advent of CD-ROM and its phenomenal storage capacity that really opened up new possibilities. For the first time, software developers had sufficient disc space to create sophisticated games, educational titles, and reference products that seamlessly integrated sound, video, and graphics with text.

Although some multimedia programs are what might be called linear (that is, the user moves from one element to another in a predetermined path), most involve some level of interactivity. This means that the user is free to navigate through various elements of text, music, spoken words, or other sounds, animation or video, and often exquisite, fully-detailed graphic illustrations. The CD-ROM that you are currently using is a multimedia program, and it is interactive because it lets you choose what and where you would like to explore next.

Most multimedia packages available at this time are for education or entertainment; however, this is quickly changing. Businesses are using multimedia packages to create presentations and develop reference material, and many libraries now offer multimedia databases for their patrons.

How Multimedia Works

Originally, most software programs were stored on floppy disks. Since each text character fills up a space known as a byte, and a typical floppy disk holds 1.4 megabytes or 1,400,000 bytes, most text-based programs could be stored on no more than several disks. Multimedia programs, however, are memory intensive: a single picture, video frame, or second of sound could require hundreds of thousands of bytes. As straight text made way for multimedia graphics, which required more space, floppies could no longer hold the information.

Developers invented another storage device that could hold a great deal more information. Known as CD-ROM (Compact Disc, Read Only Memory), it could hold 600 megabytes, over 400 times the amount a floppy could store. Very similar in appearance and concept to music compact discs, CD-ROMs can also hold text and pictures. Because CD-ROMs allow information stored on the disc to be digitally compressed, or compacted, files take up less memory, thus allowing more information to be held on a single disc. (A second generation of discs is becoming available to consumers—discs that will hold 3,000 megabytes of information, some five times the amount they now hold. As a result, multimedia programs are expected to become increasingly sophisticated as they take advantage of this phenomenal expansion of memory.)

As part of the CD-ROM development process, industry leaders Philips and Sony established standard CD formats for various types of CD material. For example, most music discs bought by consumers today adhere to the Red Book standard established for digital audio. Yellow Book is the set of technical specifications that stipulate how data is organized physically on the disc, while Orange Book specifies standards for writing audio or data to the CD. The Green Book standard applies solely to the architecture of Philips' CD-I (compact disc-interactive) products. And White Book, developed jointly by Philips and JVC, sets standards to support MPEG (Motion Picture Experts Group) video on CD-ROM, a key concern for multimedia CDs. The information stored on a CD-ROM must be accessed and translated within the user's computer. A CD-ROM player translates the data and sends it into the user's system. Unfortunately, the players can be quite slow compared to the computer's hard drive. The process will be even slower if the data needs to be decompressed. That is why there are often several seconds of delay between the selection of a topic and when it is presented on the computer monitor.

Multimedia Computers
Although most Macintosh computers come pre-equipped for multimedia use, IBM-compatible PCs may need other hardware resources to run a multimedia program. For starters, a CD-ROM drive connected to the computer either internally or externally is necessary for any computer to "play" a multimedia CD-ROM. A sound board that translates computer language into sounds that humans can understand may also be needed. And because video in some multimedia programs can be slow and jerky if run at slow speeds, many systems benefit by the addition of a video accelerator to play film or animation clips. External speakers can also substantially improve sound quality.

Although still a daunting task, connecting all these peripherals to the computer and getting them to work together is somewhat easier now than in the past. In the late 1980's, manufacturers were designing multimedia hardware and software with no set standards. Few components could communicate with any other easily, and setting up a multimedia system was often a frustrating undertaking. To solve this problem, the Multimedia PC Marketing Council (MPMC) was formed. This group now sets the standards for the industry and provides guidelines for users that outline the basic component requirements for a multimedia system.

The Multimedia Industry
Two of the earliest, and perhaps best known, of the consumer-oriented multimedia titles were Compton New Media's *Interactive Encyclopedia* and Microsoft's *Encarta.* Like most traditional encyclopedias, *Encarta* and Compton's *Interactive* contained text describing thousands of events, objects, historical figures, and places. However, they also added audio files, film, animation, and timelines that tracked events through history. Other software companies, noticing their success, have come out with similar reference and "edutainment" products. Developers have done especially well with interactive multimedia learning software for children in the areas of math and science.

Multimedia has also contributed to the film industry's increasing interest in computer technology. Produced by Philips Media, *Voyeur*, the first interactive film, broke new ground for audiences as well as for producers, directors, actors, and production crew. The video games *Myst* and *Doom* became two of the best-selling multimedia programs of all time; in fact, many computer users cited entertainment-related multimedia products as the main reason for buying a home computer. The film industry has taken a keen interest in the growing market and is now exploring the possibilities inherent in joint-venturing with (or even buying out) developers who can produce computer games based on recently released films. While few film companies have as yet had significant success with multimedia development, they continue to work with the emerging multimedia industry in the expectation that their investments will pay off in the long run.

A Multimedia Future

In the future, multimedia products may be accessed through a variety of sources. For example, interactive television, which will allow viewers to order movies on demand and communicate directly with their cable providers, will most probably be able to offer a variety of multimedia applications. On the Internet, the world's largest computer network, multimedia applications are driving the development of the World Wide Web (WWW). The fastest-growing navigational tool of the Internet, the Web uses multimedia components to link sites together using hypertext. The WWW was the first on the Internet to use multimedia in any form, and is now able to offer video footage, speeches, and updatable text components. Other players in the information marketplace, including the telephone companies, are also eagerly exploring ways to join the multimedia explosion.

A revolutionary concept that has exceeded its creators' wildest expectations, multimedia will clearly continue to be an important part of the information superhighway. As computing capacity continues its exponential growth, the sophistication of multimedia applications will no doubt keep pace.

u contributed by Leigh Ann Shevcik and Kim Dority

Multiplexing

A method of sending several signals (for example, telephone conversations) over the same transmission media at the same time. This was originally done in one of two ways: 1) by dividing a wide frequency channel into several smaller subchannels of narrower frequency, which is called frequency division multiplexing (FDM); or 2) by dividing the channel into time segments and assigning parts of the various signals to the time segments, which is called time division multiplexing (TDM). In the recent past, additional forms of multiplexing have been developed, including statistical packet multiplexing (SPM), fast packet multiplexing (FPM), and spread spectrum. All of these methods are still in use today by various members of the telecommunications industry.

Frequency Division Multiplexing (FDM)
Frequency division multiplexing was the first multiplexing technology used for remote networking. In FDM, the available transmission bandwidth of a system is divided into narrower frequency bands; then each band is used for a separate voice or data transmission channel. By spacing the carrier frequencies far enough apart, the signals can be kept distinct. AM and FM radio use FDM to broadcast several stations, or channels, simultaneously. Customers tune their receivers to a particular narrow frequency band to receive the station they desire. Frequency division multiplexing is also common in microwave telephone transmissions.

Time Division Multiplexing (TDM)
When data (as opposed to voice) transmissions became more popular and the rate at which the data was transmitted increased, a new type of multiplexing, TDM, was developed to replace FDM. Time division multiplexing divides the amount of data that can be transmitted during a specified period of time into a fixed number of time slots; each time slot is called a specific channel. First, information from channel 1 is transmitted for a moment, then information from channel 2 is transmitted for a moment, and so on in a regular sequence that cycles back to channel 1 and continues on.

In early TDM systems, a specific data source was assigned to a specific channel (or time slot); this data source could not be changed dynamically. Unfortunately, the static nature of the channel assignments meant that even if a data source was inactive, resulting in an inactive channel, the time slot dedicated to that channel was unavailable for use by any of the other data sources. In addition, if that channel was in use for voice transmission, there was no way to take advantage of the “dead space” that occurred in any conversation. To overcome these shortcomings, another, more complex, multiplexing technology was needed.

Statistical Packet Multiplexing (SPM)
Statistical packet multiplexing is a form of TDM in which data channels are assigned to available time slots as they are needed. Since not all of the data sources are in use all of the time (which in older systems would have resulted in idle or under-used channels), the total number of active terminals or other data sources may exceed the number of available time slots. The term *statistical* refers to this “bursty” nature of data; in other words, data is often sent in bursts (like human conversation) as opposed to a steady flow (like video

programming, music on hold or fax).

At the network interface, SPM gathers an active channel's data into a packet, adds identifying and control information to the packet, performs any compression or encryption that is necessary and sends the packet off to the next network multiplexer node. This multiplexer receives the packet, checks for any transmission errors and requests retransmission if any errors are found. If the packet is error-free, it is sent to the next multiplexer and so on until it finally arrives at its destination.

The constant error-checking at each multiplexer can create problems for some time-sensitive types of data, primarily voice and video. Since the presence or absence of error cannot be predicted, it is also impossible to anticipate or predict any delays that may occur. For this reason, many networks use a combination of TDM and SPM for various types of voice, data and video transmissions.

Fast Packet Multiplexing (FPM)
To solve the time delay problem of SPM networks, FPM was developed. Like SPM, FPM gathers a channel's data into a packet for delivery over the network, but because FPM does not perform SPM's error detection and correction at each intermediate network multiplexer, it avoids the delay problems of SPM. Rather than store and review the data, FPM multiplexers forward a packet before it has been completely received. This means the packet can be going out one network port of an FPM multiplexer while it is still coming in another network port. FPM assumes that the network connections are sufficiently reliable that the packet contents only need to be inspected at the final destination, where any corrective action is performed. By avoiding SPM's packet inspection delay, FPM achieves far fewer network delays.

Another advantage of FPM is its ability to interrupt the delivery of one channel's packet in favor of delivering another, more time-sensitive, channel's packet. FPM can reallocate bandwidth to the time-sensitive channel even while the packet is being transmitted. Because of this, FPM can ensure that time-sensitive information will not have to wait for an unpredictably long packet to finish transmission before the transmission of the time-sensitive information begins. Voice and video are the two areas where these time concerns are most important.

Spread Spectrum
Spread spectrum is the name of the latest advance in multiplexing. In the telephone industry, it is also referred to as code division multiple access (CDMA), where it is used in a new form of digital cellular phone service. Yet another name for spread spectrum transmission is frequency hopping.

Spread spectrum modulates a data signal so that it occupies more of the radio band than necessary. This spreading of the data was originally developed in World War II to protect signals from eavesdropping and interference, although it has not come into popular use until much more recently. In its current form, the input signal is mixed with special random FM noise and spread over a broad frequency range, hopping from frequency to frequency in split-second intervals. Spread spectrum receivers collect the signal and "de-spread" it. One type of spread spectrum transmission called pseudo-random sequence is highly secure. Anyone attempting to eavesdrop on the signal hears only unintelligible blips and any attempt to jam the signal only succeeds in knocking out a few bits of the original message. The concept is so effective that it has now become the principal anti-jamming method in U.S. military communications.

Another type of spread spectrum transmission currently being used involves the insertion of redundant data bits called *chips* into the signal. The receiver knows the transmitter's spreading code and where redundant chips are inserted. At the receiving end, the redundant bits of information are removed and the signal is collapsed to its original length.

All of the various forms of multiplexing, from simple frequency and time division to complex spread spectrum, are in use today. Some are more time-sensitive, others more error-sensitive, and still others are more security-sensitive. The type of multiplexing employed depends on the user's needs; but any of them can achieve the original purpose, which is to send several signals over the same circuit at the same time.

u contributed by Linda Stranahan

Multipoint Distribution Service (MDS)
Multichannel Multipoint Distribution Service (MMDS)

Wireless methods of delivering television and other signals. Since they use microwaves to transmit the signals, the receiver must be in line-of-sight with the transmitter.

Multipoint Distribution Service (MDS)
Multipoint Distribution Service (MDS) is a closed-circuit microwave distribution technology that delivers signals to multiple fixed locations. Receivers must be within a 30-mile radius. MDS can carry television and other signals and is often used to provide television programming to hotels and apartment buildings. MDS is a common carrier, meaning that it offers communication services to the general public. As a common carrier it is controlled by the Federal Communications Commission (FCC). Canada has not authorized MDS services.

As a common carrier, MDS is protected by law from unauthorized reception. Unlike other broadcast mediums, MDS ownership is not restricted; therefore, one company can own or partner with other companies to own and operate any number of systems.

MDS is a low cost method of constructing a reliable delivery system. However, its limitations include an inability to carry more than two channels and the tendency of MDS signals to be affected by rain, snow and other obstructions. Despite these drawbacks, HBO and Showtime utilized MDS to provide programming to subscribers before satellites were used to distribute signals.

Multichannel Multipoint Distribution Service (MMDS)
Also called **Multichannel Television** (MCTV).

Multichannel Multipoint Distribution Service (MMDS) is a microwave distribution system capable of transmitting up to 32 channels. The downconverter, which receives the signal, is tuneable from one channel to another and can accommodate over-the-air programming. Like MDS, it can be used to deliver television signals to hotels and apartment buildings. MMDS operators are not allowed to program the channels themselves.

MMDS equipment is less costly than cable television equipment and an MMDS system is faster and cheaper to construct. Because of these cost factors, MMDS can be used to serve smaller markets; sparsely populated areas; or to distribute signals in places, such as large downtown areas, where cable construction costs are high.

Currently, MMDS has two disadvantages; the number of channels that can be transmitted and the requirement of line-of-sight between the microwave transmitter and the receiver. However, in the near future television signals will be digital, rather than analog, and can be compressed. This will allow MMDS to carry more than 128 channels and opens the technology to interactive services such as pay-per-view (PPV) movies.

MDS and MMDS are positioned to be strong competitors with cable television and other wireless technologies, such as Direct Broadcast Satellite (DBS) and Satellite Master

Antenna Television (SMATV). MDS and MMDS could suffer losses in customers as cable and DBS extend into less populated areas, but these losses may be offset by growth in urban areas.

u contributed by Paul Stranahan

National Public Radio (NPR)

A supplier of radio programming, governmental representation and managerial consulting to 520 noncommercial member radio stations. NPR is based in Washington, D.C.

Public radio dates back as far as commercial radio in the United States, to the 1920's; but commercialism and economics nearly forced an end to it. Fortunately, during the 1950's and 1960's, as public television was finding its way in the powerful medium of broadcasting, public radio was able to tag along. During this time, interest, funding and development were normally centered around TV, with radio a mere afterthought. Yet those who believed in educational or public radio used public television's growth to their advantage. In 1967 the Carnegie Commission on Educational Television issued a report on the future of public TV. The report was the basis of the Public Broadcasting Act of 1967, signed into law by President Lyndon Johnson. The report discussed television, but the Act also included radio.

A provision in the Act directed the formation of the Corporation for Public Broadcasting (CPB), which was allowed to oversee government-appropriated funds and interconnection of public television and radio stations. The television station interconnections were managed by Public Broadcasting Service (PBS), launched in November 1969 by CPB. The radio counterpart, NPR, was launched three months later in February 1970, and its first network transmission was broadcast on April 19, 1971. From then on, the two broadcasting entities supervised by CPB — PBS and NPR — started to look and act differently from each other.

In its infancy, NPR only produced and transmitted programming. But in 1977 NPR merged with the Association of Public Radio Stations and took on additional management and government representation duties.

In 1978 PBS became the first U.S. television system to utilize a satellite to deliver programming. The next year, NPR became the first radio system to do so. Satellite transmission became the first of many positive steps NPR took in the early 1980's, an era that was full of challenges for the growing service. NPR was trying to loosen some of its ties to CPB and become more self-sufficient. In 1982 NPR promoted a six-year plan for total independence. A year later, the plan collapsed and the future of NPR was in doubt. CPB, the entity from which NPR was trying to break away, loaned much-needed money to the radio service for survival. The debt forced cut-backs, lay-offs and a leaner operation along with more, not less, dependence on CPB.

In 1987 NPR went through another restructuring. A major change was funding. Previously CPB had sent operation and production funds to NPR. After the restructure, CPB sent funding directly to the public radio stations. Currently NPR gets only about 4 percent of its direct funding from the government. Much of the self-sufficiency it sought has been realized, yet the direct link and nearly automatic sales to its member radio stations have been lost. Today many stations receiving programming and funding from NPR and CPB participate at a variety of levels.

With the 1987 restructuring, NPR un-bundled its programming and allowed each member station to pick and pay for as little or as much programming as it wanted. Additionally stations started producing more of their own programming and, when appropriate, made it available for national consumption. A prime example of successful local-to-national programming came from Minnesota Public Radio's *A Prairie Home Companion* with the multi-talented Garrison Keillor .

Keillor's show came to NPR by way of American Public Radio (APR), a competing public radio network founded in 1982. APR is structured more like a traditional broadcast network because it has market-exclusive affiliates. Although APR does not produce programming, it was the broker for *A Prairie Home Companion* in its first year, which led to other successful programming arrangements. APR is a member of NPR, and while APR is not a 24-hour service, it has over 400 affiliates. Many public radio stations subscribe to both NPR and APR as well as a handful of other program suppliers. Indeed, the multiple suppliers ensure a diversified source of programming possibilities for all public radio stations.

While NPR is known for its news, cultural and information programming from its Programming Division, it also has two other divisions: the Representation Division is the voice of member stations to the government; the Distribution Division has control over the satellite relay system and transmission and is exploring the next generation of satellites, fiber optics and digital sound. NPR member stations pay separately for representation and distribution.

Funding for NPR comes from a variety of sources, including 60 percent from listener membership dues. Another nearly 30 percent comes from grants, contracts and contributions. In early 1995, newly elected House Speaker Newt Gingrich suggested that the government stop the subsidy of public broadcasting. And, in fact, the House Appropriations Committee has voted on legislation that schedules elimination of funding by 1998.

What traditional commercial radio does extremely well is provide immediate news coverage. What commercial radio typically does not do well, but what NPR has focused on, is in-depth, understandable news on relevant topics, which seems to be just what its listeners want. Public radio's audience is a bit more educated, in a higher income bracket and more actively involved in the community than commercial radio audiences. Studies also show that NPR listeners gather news information from many sources; so it was not surprising that when Mr. Gingrich announced his goal of eliminating subsidies for public broadcasting, a commentary was aired over NPR that actually agreed with him. In fact, private funding may be the future for NPR and other public broadcasters.

Undoubtedly, NPR's attention to technology along with its history will make for an interesting future.

u contributed by Michele Messenger

National Broadcasting Company, Inc. (NBC)

The National Broadcasting Company (NBC) was the very first American company formed for the specific purpose of operating a broadcast network. Like its two immediate successors, the Columbia Broadcasting System (CBS) and the American Broadcasting Company (ABC), NBC started as a radio network and naturally evolved into a television network as that industry developed. NBC is now headquartered in New York City.

In the dark ages of radio, many companies as well as amateurs were inventing and developing radio transmitters and receivers. The result of thousands of patents was that no one source could produce a single radio package for sending and receiving.

One of the many patent holders was General Electric (GE). GE owned the rights to a reputedly successful alternator – a way to transmit radio waves. However there was only one potential customer for this equipment: a British client. Not wanting this powerful equipment to get out of American hands and also not wanting to fight with the government on this issue, GE set up its own corporation and named it Radio Corporation of America (RCA) in 1919. (Eventually it developed into a consortium that included Western Electric, American Telegraph & Telephone [AT&T], and Westinghouse Electric Corporation.) Patents and rights were hammered out and in the end RCA had the responsibility for the 2000-plus patents and became the seller of radios made by Westinghouse and GE. Western Electric, the manufacturing subsidiary of AT&T, had the rights to manufacture the equipment necessary for transmitting. Loosely translated, AT&T sent the sound out and RCA received it. Finally, the radio business was ready to go.

By the early 1920’s RCA was ready to sell radio receiving sets. Unfortunately the demand did not meet the supply. What was the most logical way to boost sales and reduce inventory? Produce radio programs and start a network on which to air them. RCA’s consortium gave birth to the National Broadcasting Company (NBC) and on November 15, 1926, with 21 charter affiliates and four additional outlets, NBC was on the air. The Columbia Phonograph Broadcasting system, later known as CBS, would go on the air with its 16 affiliates ten months later.

Within a year NBC, by way of parent RCA, had two radio stations in the same listening area, New York and Newark. NBC formed two independent networks linking off from each station. The New York station, WEAF (originally owned by AT&T and started in 1922), became the headquarters of the Red Network. WEAF is now WNBC. The Newark station, WJZ (started in 1921 by Westinghouse), became the link for the Blue Network. The Red Network was the strongest in terms of programming. In the early 1930’s, GE sold RCA, which then bought out the other participants in the consortium and became the sole owner of NBC’s Red and Blue networks.

The reason for the two colors was simple. Red and blue were the two colors of the cables used to keep the networks separate at the switchboard. Both radio commercials and programs had been on the air for a few years, but the style, format, stars, affiliate relationships and economic systems that would be passed on to future radio stations were determined by the young networks Red, Blue, and CBS. Two decades later when television was in its infancy, they would utilize the radio format. During this young, exciting time the character and tone of both RCA and NBC was firmly set in place by the President of both companies, David Sarnoff . Sarnoff's first contribution to the industry was NBC itself. In the beginning networks were temporarily used to broadcast an event. Sarnoff thought they should be permanent and was an initial proponent of RCA's offspring NBC. Sarnoff was interested in the technology of things. He set the environment for invention, development and risk at RCA and NBC.

In 1941 the Federal Communications Commission (FCC), in the Chain Broadcasting Regulations, ruled that NBC had to sell off one of its networks. In 1943, when the ruling went into effect, the Blue Network was sold to the man responsible for Life Savers Candy, Edward J. Noble, who took it and formed the American Broadcasting System and later American Broadcasting Company (ABC). Experimental, regular and network television were started by NBC in 1931, 1939, and 1941 respectively. The entire country's focus and efforts on World War II slowed down the giant leaps the industry and its technology had been making. But the activity in the post-war years made up for the previous slow-down.

Once again, as with radio two decades before, RCA was interested in pushing programming and coverage, this time in television. The company was manufacturing television sets and needed to offer the public an incentive to buy. So NBC moved into television programming with four stations in 1946. Shows like NBC's *Kraft Television Theater* and *Howdy Doody* and then *The Texaco Star Theater* with Milton Berle pulled people into the stores to buy television sets. Many radio programs were simply switched from radio to television. CBS, the giant, gained much of its star status by pulling away much of NBC's on-air talent. So NBC simply found and developed more talent, and kept pushing for television technology.

When RCA bought the original Red Network station from AT&T in 1926, part of the agreement was that RCA would use AT&T for network interconnection. So as fast as AT&T's interconnection technology and network programming prospered, new radio and television stations went into business and on the air. As the radio networks made the natural progression to television networks, information and entertainment from broadcast sources became a reality for Americans everywhere. Coast-to-coast television service occurred with the September 4, 1951, network "pool" coverage of the signing of the Japanese peace treaty in San Francisco.

Yet again, RCA's financial interest in advanced television technology (this time color television) was the only impetus NBC needed to make the change to all-color programming. CBS and RCA were in a duel to get FCC approval on a color system. CBS had even hired Peter Goldmark, the long-playing record inventor, to develop a system in 1936. But RCA got there first, sort of. In 1940 CBS had a mechanical color system ready to go. The FCC apparently did not give it serious attention until 1950 when the commission approved it. In a rare reversal, the FCC revoked the CBS license for the color system and changed the industry standards to an electronic one. RCA had developed an electronic color system and was ready to go. So RCA won the rights in 1953.

The 1950's, 1960's and 1970's were a profitable time for the three television networks. Each had its niche and ranking. CBS was strong in entertainment and was the overall number one network. ABC was covering an under-served market, sports, and was struggling as the number three network. NBC was usually in the number two spot and focused on news. While David Sarnoff and later his son, Robert, were both instrumental in setting the tone of both RCA and NBC, two additional men had more to do with the "look" of NBC. Sylvester "Pat" Weaver , were part of Kintner's legacy to the industry. Strong TV journalists such as Frank McGee, John Chancellor, Edwin Newman, Sander Vanocur, Irving R. Levine, Barbara Walters, and many, many other prominent news names flourished under Kintner. These on-air journalists were backed by a strong team of writers, editors, producers and executives. For all of these people, the emphasis was always on journalism.

In 1975 in a corporate shakeout, Robert Sarnoff, who had succeeded his father as Chairman of RCA, was replaced. By the early 1980's, Thornton F. Bradshaw, the new Chairman of RCA, had growing concerns regarding the leadership in the company. During Bradshaw's tenure Grant Tinker, Chairman of NBC; Brandon Tartikoff, programming chief; and Lawrence Grossman, head of the news division, all contributed to NBC's renewed strength. By 1986 NBC found itself in the number one spot. Bradshaw's concerns, however, were founded on the fact that the hungriest business vultures were circling and buying stock. Bradshaw was concerned that someone would buy enough stock to control the company and sell off the divisions. Separately the divisions were worth more money than the company as a whole, and quite simply, RCA's communications and electronics divisions couldn't survive without NBC.

Bradshaw had discussed selling or merging RCA with MCA, the Disney Company, or General Electric (GE). In 1986, GE, run by CEO Jack Welch, bought RCA for $6.3 billion. NBC was now owned and managed by a totally new company and while there was a shared history, GE's style was decidedly different. Tartikoff stayed with NBC until 1991, but Grant Tinker left in 1986. Welch designed his lean management team with Robert C. Wright as President of NBC. Welch sold off all of the radio properties including the original NBC Radio Network. Westwood One bought the network and has retained the name.

The last half of the 1980's were a twisting road for NBC; indeed, this was the case for all three major networks. They were not only battling with each other, but they also had new competition from the upstart Fox Network to contend with. Add cable, VCR, fickle viewers and syndicated 'soft' news shows to the mix and all the networks were having to adapt, re-define, change and compromise.

None of the networks was built on a single show or theme anymore, but if there was one thing that audiences naturally associated with NBC it was *The Tonight Show*. And that little corner of the world was also about to change. Johnny Carson was scheduled to appear at the 1991 affiliate meeting. This was the network's opportunity to wrap up the previous season and start promoting the upcoming one for the affiliates. Stars, shows and plots were introduced. Carson's appearance was a well-kept secret and scheduled to wrap up the events. It was at this meeting in front of all of the affiliates, the press, big advertisers and the so-far-in-the-dark NBC executives that Carson announced he was retiring from *The Tonight Show*. He went so far as to name the date: May 22, 1992. While a handful of executives knew he had been toying with the idea for some time, no one knew Carson was ready to make the announcement. Top executives, Wright, Warren Littlefield, Dick Ebersol and Perry Simon were all in the audience and were equally stunned. They had no idea of Carson's plan and this news hit them like a meteorite falling from space.

Comedian Jay Leno was eventually announced as Carson’s successor, so David Letterman, the popular host of *The Late Show* in the time slot after *The Tonight Show,* left the network in a semi-public fight and business settled down to the normal twisting road again. By the mid 1990’s that road included even more cable penetration and acceptance, tremendous gains by the Fox Broadcasting Company, affiliation switches affecting the entire country and, by 1995, the addition of two new networks, the Warner Brothers Television Network and United Paramount Network. Talk of the information superhighway had companies alternately embracing the idea and running from it. Definitions of success would probably change again for the original three television networks. The only thing NBC and the others could not do was take any threat too lightly. Being on guard would be hard work.

In 1991 when Carson stunned the audience at the affiliate meeting and concluded his “act,” Warren Littlefield, in a state of business-shock, wrapped it all up with “That’s our show. Down the hall and to the right, you’ll find the bathrooms...” For NBC, being on guard is going to be very hard work.

u contributed by Michele Messenger

Editor's Notes:
A number of major companies are working together to develop Intercast technology, an interactive data delivery medium conceived by Intel. The Intercast Industry Group's goal is to create a service which combines television technology with the World Wide Web, allowing end-users to jump between television shows and web pages with the click of a button on a remote control. Companies involved in the effort include Intel Corporation, Continental Cablevision Inc. (under the ownership of US West), Tele-Communications, Inc., Time Warner Cable Programming, General Instrument Corporation, TCI's Headend-in-the-Sky, NBC, Turner Broadcasting, Viacom International, WGBH Educational Foundation, QVC, America Online, Asymetrix, En Technology, Netscape Communications Corporation, Gateway 2000, and Packard Bell.

Wright, Robert C. "Bob" (1943 –)

American businessman and television executive, currently the President and Chief Executive Officer (CEO) of the National Broadcasting Company (NBC). Wright was named to the head post when General Electric (GE) bought the Radio Corporation of America (RCA), the previous owner of NBC.

NBC is the United States' oldest broadcast network. Its first days as a radio network date back to 1926. The network's strength over the years has always been news and entertainment, not to mention longevity.

When GE bought RCA, GE Chairman Jack Welch placed Wright at the head of NBC. Welch chose a strong man. GE also chose for NBC an organizational chart different from the other two established networks. Columbia Broadcasting System (CBS) was taken over by the Loews Corporation in 1986 and its co-CEO, Laurence Tisch, took and still has control over the network. His next-in-command is Peter Lund, President CBS/Broadcast Group. At the American Broadcasting System (ABC) the man in charge is Thomas Murphy. He is the CEO of Capital Cities/ABC, Inc., the parent company. Murphy's right-hand-man is Robert Iger, President and Chief Operating Officer of Capital Cities/ABC, Inc.

Of the three national television network leaders, Bob Wright is the only one with the specific title of CEO who reports to the CEO of the parent company. And while Welch was highly visible during negotiations for the sale of RCA to GE and is the man ultimately responsible for NBC's success, Wright is the one he chose to lead NBC.

Wright, raised in Hempstead, New York, has worked for GE for nearly his entire adult life. His most recent title while at GE was President of General Electric Financial Services. While heading that company, Wright doubled its assets.

When GE bought NBC, Welch and Wright were extremely concerned about the network's expenses. They immediately began cutting costs and preparing for a future in which the networks didn't dominate the medium. Their expense trimming, and to some extent Wright's appointment, met with resistance from some network executives who saw Wright as a corporate non-broadcaster. Similar versions of angst and discontent were being experienced at the other networks as well, however. Although GE's management style was very different from RCA's, over time Wright has assembled a team that he trusts and whose members work well together.

One of Wright's desires is to start new networks — for example, one devoted solely to news and yet another to entertainment. Present Federal Communications Commission (FCC) rules prevent dual network ownership and affiliation, but there are always rumors that the government might loosen the tight regulations guarding over-the-air networks. Currently the networks' rivals, cable companies, face fewer restrictions than do the broadcast networks in this area, but the FCC is still reviewing this issue.

Throughout the mid-1990's Wright also explored other opportunities for the network:

NBC went on-line and then on the Internet; talks concerning selling the network to parties such as Ted Turner were reported; and NBC challenged the FCC's license to Fox Broadcasting Company (Fox) owner, Australian-born Rupert Murdoch. In 1994, when Murdoch's investment in 12-station New World Communications Group forced the re-arrangement of network affiliates all over the country, Wright and his contemporaries at CBS and ABC had to scramble to find new affiliates in some key markets. As for all broadcasters, programming and its challenges were very time-consuming. For a man who previously didn't watch all that much television, Wright found himself in the news as well as broadcasting it.

As NBC continues to make the most of the foundation it has built on quality newscasts and excellence in programming, Bob Wright's management and leadership will be invaluable.

u contributed by Michele Messenger

Neural Networks

Modeled after the brain's nerve functions, neural networks allow computers to actually learn by simulating how the human mind processes information, learns and remembers. Neural network research has long been a cornerstone of the branch of computer science known as artificial intelligence.

Artificial intelligence (AI) research, which began in earnest in the 1950's and continues to this day, strives to develop machines that can process information like human beings. A major portion of this research focuses on designing systems that mimic the function of the human brain. These systems are known as neural networks.

Neural networks are interconnected processing elements composed of inputs and outputs modeled on the brain's networks of neurons and synapses. Unlike traditional computer processing, which relies on programming methods that specifically detail the function of each of these elements, neural networks are designed to actually learn through receiving and processing information from weighted electrical pulses, which can range from weak to strong or from positive to negative. Learning takes place as the elements in the neural network, originally connected in random patterns, create the pattern required to generate the desired results by adjusting their function over time based on the information they receive.

It is possible to build neural networks in several ways. The easiest and fastest method is to construct hardware circuits to process the electrical pulses. It is also possible to design software that simulates the hardware network; however, this method is slower and more cumbersome.

The first neural networks, developed in the early 1960's, proved to be somewhat faulty, and the ideas behind the networks were largely discredited. However, neural networks regained popularity in the 1980's when technological advances enabled the creation of transistor networks on computer chips as well as the simulation of these networks in software that could run on personal computers.

Today, neural networks are enjoying a resurgence as the need for computer systems capable of learning to analyze and recognize information continues to grow. Because neural networks are capable of recognizing and identifying vocal and visual patterns, they have proven to be most successful in applications requiring pattern recognition, speech analysis, or speech synthesis. These applications include speech, handwriting and character recognition, trend analysis, parts inspection and radar analysis.

u contributed by Sonia Weiss

Noorda, Raymond J. (1924 –)

American business executive best known for transforming Novell, Inc. into a world leader in the field of computer networking software.

Ray Noorda was born on June 19, 1924, in Ogden, Utah. In 1949, he graduated from the University of Utah with a bachelor of science degree in electrical engineering. Noorda spent the early part of his career at General Electric honing his skills as a computer systems engineer. He later joined General Automation, Inc. as Executive Vice President and subsequently became President. After serving as the President of Systems Industries Inc., he became Chief Executive Officer of Boschert Inc., a manufacturer of power supply systems.

In 1983, Noorda assumed the leadership of Novell, Inc., a small, struggling computer hardware manufacturer located in Orem, Utah. Noorda prophesied that the future of business computing would lie in linking — or networking — personal computers (PCs) together rather than using large mainframe computer systems. His strategy for Novell was to get out of the computer hardware business and focus instead on creating and marketing networking software. With this approach, Novell's sales boomed and, because the network software business offers higher margins, profitability also soared. Novell, previously facing bankruptcy, was on the way to becoming a world leader in networking technology.

By the end of the 1980's, Novell's business customers were clamoring for software that would link PCs to other business systems that contained information such as operations records and specialized databases. Unfortunately, much of this existing equipment had been purchased from a variety of manufacturers, resulting in incompatible systems that were unable to exchange crucial data. In 1989, Novell introduced groundbreaking software that would overcome this difficulty. It was compatible with systems including Macintosh and IBM and allowed users to access all the computers and information linked via their unique network.

Today, computer networking software is the fastest growing segment of the computer industry. Novell has developed an estimated 75 percent of the networking products now available in the global marketplace, and its revenues exceed $1.1 billion. Under Noorda's leadership, Novell's strategy has included using joint ventures and acquisitions to enhance its own technology development and challenge its primary competitor, Microsoft Corporation. Noorda, however, is not without his detractors. Some claim that Noorda-led acquisitions, such as WordPerfect Corporation, have diverted Novell from its focus in networking products.

Noorda's leadership style is characterized as relaxed but tough on the bottom line. When traveling, he often flies standby to take advantage of seniors' discounts, shares accommodations with other executives and frequents budget restaurants.

In April 1994, Noorda handed over his responsibilities as Novell's President and Chief Executive Officer to his chosen successor, Robert J. Frankenberg. He remains an active member of Novell’s Board of Directors.

u contributed by Susan P. Sanders

NYNEX

The regional Bell operating company (RBOC) — also known as a Baby Bell — that provides local telephone service to a region extending from New York to Maine, along with cellular, Yellow Pages and other communications services.

As part of a 1984 antitrust settlement with the U.S. government, AT&T spun off its local operating subsidiaries into seven regional Bell operating companies (RBOCs) — also known as Baby Bells. NYNEX, the entity that replaced New York Telephone and New England Telephone, provides local telephone service in Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island and Vermont. It also furnishes directory publishing and cellular services, and shares Bell Communications Research (Bellcore) with the other six Baby Bells.

NYNEX received the most outdated network of the seven Baby Bells from the AT&T divestiture. While providing service to 12 million customers and investing millions to modernize, the company has faced challenges that include a struggling local economy, strong labor unions and competitors who want NYNEX's access to New York City, which is the nation's most communications-intensive location.

When NYNEX CEO Ivan Seidenberg announced 1994 fourth quarter profits of over $198 million — compared with a loss of $1.24 billion during the same period in 1993 — he characterized 1994 as a year of growth and attention to basics. He credited the company's performance to improved customer service, reduced costs, innovative marketing, favorable labor agreements and strategic alliances in emerging markets that include wireless, information and entertainment services. He pledged that the company would continue to streamline its operations and seek out domestic and international growth opportunities.

NYNEX, a major publisher of U.S. and overseas directories, is dedicated to effectively using technology to support customer information access needs. For instance, the company produces a digital directory containing over 10 million listings, and a NYNEX on-line directory provides electronic customer listings. Compact disc-based Yellow Pages are among the services currently being evaluated.

In mid-1994, NYNEX and RBOC Bell Atlantic announced they would combine their cellular entities to develop comprehensive wireless communications capabilities for a wide, as yet undefined, market area. Subsequently, the two RBOCs also formed an alliance with another RBOC, U S WEST, and AirTouch (the cellular subsidiary spun off in 1994 by RBOC Pacific Telesis Group) to develop easily accessible, nationally standardized personal communications services (PCS). Initially, the new alliance is focused on obtaining the necessary Federal Communications Commission (FCC) licenses to launch the new products.

RBOCs Pacific Telesis Group (PacTel) and Bell Atlantic are collaborating with NYNEX to develop and deliver home entertainment, information and interactive services. The group has partnered with Creative Artists Agency, Inc. (CAA) to create original programming. The technology side of the initiative will focus on developing the systems required to deliver programming over the telephone companies' new video dialtone (VDT) networks. In addition, NYNEX has invested in Viacom, which has already begun to produce programming for NYNEX's United Kingdom interests.

According to Seidenberg, NYNEX plans to significantly increase its presence in global communications during the next decade. The company's international strategy is to transfer its domestic expertise to overseas markets. NYNEX owns a portion of TelecomAsia, which built a two-million-line Thai telephone system, and has invested in a United Kingdom cable company and telephone service provider. In 1993, NYNEX and a European business entered a joint venture to develop residential information services for visual-display telephones. NYNEX also has operations and investments in Greece, Indonesia, Japan, Poland and the Czech Republic.

u contributed by Susan P. Sanders

Seidenberg, Ivan G. (1946 –)

American business executive, currently Chairman, President and Chief Executive Officer of NYNEX, a regional Bell operating company (RBOC).

Ivan Seidenberg was born in New York City on December 10, 1946. He earned his undergraduate degree in mathematics from City University of New York in 1972, and an MBA from Pace University in 1980.

In 1966, Seidenberg began his communications career at New York Telephone. After serving as a sergeant in the U.S. Army and being stationed in the Republic of Vietnam from 1967 to 1968, he returned to New York Telephone and held a variety of engineering and operations positions. From 1974 to 1982, Seidenberg worked at AT&T in positions related to engineering, rates and tariffs, and federal regulatory issues. Seidenberg joined NYNEX in 1983 as Vice President of Government Affairs based in Washington, D.C. He moved to New York in 1986, and was named Vice President of External Affairs for NYNEX. Seidenberg was appointed Senior Vice President in 1988, and remained in this position until May 1990. At that time, he was named NYNEX Executive Vice President and President of NYNEX Worldwide Information and Cellular Services Group. In March 1991, Seidenberg was elected Vice Chairman of the NYNEX Telecommunications Group.

Seidenberg became President and Chief Executive Officer of NYNEX in January 1995; in April 1995, he became Chairman and Chief Executive Officer. In his current position, Ivan Seidenberg is responsible for all NYNEX operations serving 14 million telephone, cellular, directory and cablecustomers in the United States and selected global markets.

In addition to his responsibilities at NYNEX, Ivan Seidenberg serves as a member of the board of directors of Pace University, Melville Corporation, National Planning Association, Viacom, Inc., Rockland Economic Development Corporation and the New York Hall of Science. He is former Chairman of the United States Telecommunications Association.

u contributed by Susan P. Sanders

O’Reilly, Henry (1806 – 1886)

Irish-born American editor, author and pioneer in the construction of telegraph lines.

Henry O’Reilly was born in Carrickmacross, Province of Ulster, Ireland. His father was a merchant who experienced financial difficulty in business. His mother was the daughter of a physician. The family of three emigrated to America in 1816 and settled in New York. Young Henry O’Reilly apprenticed to Baptiste Irvine, editor and owner of the New York *Columbian*, a spirited and effective liberal journal, which was a staunch advocate of the Erie Canal project. With a change in the ownership of the paper, O’Reilly’s apprenticeship terminated in a year. At the age of 17, he became Assistant Editor of the New York *Patriot,* a periodical of John C. Calhoun and Henry Wheaton and the mouthpiece of the People’s Party, which elected DeWitt Clinton Governor of New York in 1824. This experience made such an impression on O’Reilly that it dominated his mature political thinking.

Pioneer, fighter, and confirmed romantic, O’Reilly proceeded to the remote village of Rochester, New York, with his friend Luther Tucker and established the *Rochester Daily Advertiser*. Response to the community’s first daily paper was robust. Life in the rugged frontier community stimulated O’Reilly’s active mind, and numerous causes enlisted his support. In his early years he labored for the re-election of President Andrew Jackson, preached for the improvement of the Erie Canal, advocated the cause of Irish Independence, worked for the social betterment of Rochester, and wrote innumerable pamphlets on the problems of the day. In 1838, O’Reilly also published *Sketches of Rochester, with Incidental Notice of Western New York*.

Personally ambitious, he unsuccessfully ran for the State assembly as a Jacksonian Democrat in 1836. The following year, Postmaster General Amos Kendall appointed him head of the Rochester Post Office. As an assistant O’Reilly chose a young Scot immigrant, James D. Reid. The routine of the post office could not satisfy the crusading zeal in O’Reilly’s soul, and in 1842 he put aside his routes and schedules to take up the editorial pen of the *Albany Atlas*, a journal advocating constitutional reform. This was precisely to his liking. So earnestly did O’Reilly and others plead the cause that a new constitution for New York was drafted in 1846.

In 1845, O’Reilly entered into a contract with Samuel F.B. Morse and Amos Kendall to raise capital for the construction of telegraph lines from Eastern Pennsylvania to St. Louis and the Great Lakes. Under this contract, O’Reilly had erected some 8,000 miles of line, but in the course of the venture broke the terms of his contract. The O’Reilly contract with the patentees was a masterpiece of ambiguity. This famous document, under which the Atlantic, Lake & Mississippi Telegraph Company prepared to operate, was to lead to more dissension and create more litigation than any other single agreement associated with the early lines. The litigation and added financial difficulties led O’Reilly to entirely abandon his connection with the telegraph by 1858.

However, O’Reilly was constantly advancing a cause. In 1859, when the railroad interests were hostile to the Erie Canal, he followed up his 1833 appeal for improvement by again appealing to the people of the state to protect the interests of the waterway. He also gave collections of historical manuscripts to both the New York Historical Society and the Rochester Historical Society.

Reid, in his book *Telegraph in America*, said of his former boss that O'Reilly's "Mental activity and power of continuous labor were marvelous. He was liberal, generous, profuse, and full of the best instincts of his nation. But he lacked prudence in money matters, was loose in the use of it, had little veneration for contracts, was more anxious for personal fame than wealth. He formed and broke friendships with equal rapidity, was bitter in his hates, was impatient of restraint."

O'Reilly was married to Marcia Brooks, a daughter of General Micah Brooks. They had one son, Henry Brooks O'Reilly, who was killed at the battle of Williamsburg May 5, 1862. A remarkable man, O'Reilly recognized the telegraph's potential and acted upon his vision for a mighty system that stretched from the eastern seaboard to the Mississippi and embraced all the territory west of Philadelphia lying between the Ohio River and the Great Lakes.

u contributed by Diana L. Hollenbeck

On-line Services

Wide area networks (WANs) offer communications services to paying members. Most offer E-mail, limited Internet access, searchable on-line databases, forum areas where members can discuss a variety of subjects, games, and chat rooms. Many on-line services are owned, at least in part, by major corporations, such as Sears and Microsoft.

There are three types of value added networks (VANs) that offer on-line communications services to members who pay a monthly subscription fee. While all operate to make a profit, they vary greatly in size, scope, and type of benefits. Falling in the first category are small, locally oriented groups known as bulletin board services (BBSs). Their membership base is usually confined to a city, county, or telephone area code. Many BBSs are free to users (who are responsible for phone charges, however). Most BBSs offer E-mail, some Internet access, shareware (computer programs users download and pay for later if they want to keep using the product), and forum areas. Many BBSs are theme-oriented; for example, users might be fans of the television program *Star Trek* or the video game *Doom*.

The second type of commercially oriented on-line services are Internet service providers. The Internet is the world's largest computer network and connects over 25 million users worldwide . These providers, such as Netcom and UUNet, sell users Internet access time. They might have some member-only benefits such as mailings lists and Usenet groups, but their scope is limited to internal discussions and questions.

The final group is composed of commercially oriented, regional and national on-line service providers that exist to make a profit. Many are owned by corporations who charge users a monthly fee to access the service. Almost all of these on-line services offer forum areas, limited Internet access, shareware, games, live chat rooms, and searchable on-line databases. However, the fee, log-on time, types of subscribers, and content available can vary greatly.

Today there are five main on-line services: America Online (AOL), Prodigy, CompuServe, GEnie, and Delphi. They offer local connection sites throughout the United States. Members can access them from most types of computers, including IBM-compatibles and Apple Macintoshes. These five services control over 95% of the market, but they are not the only on-line services available to users. Several others include:

u E-World, started by Apple in 1994, a national network currently only available to Macintosh users.

u The Imagination Network from Sierra Online, a service geared towards children and families, that lets users play video games against others.

u The WELL, a legendary Northern California on-line service, famous for its community focus and large user base of media and computer professionals.

u The Wall Street Journal service, which lets users monitor portfolios, check stock prices, and trade stocks on-line.

Within the next few years, other companies, such as Microsoft and MCI, will be starting new, nationally oriented on-line services to compete with the ones listed here.

Unlike many BBSs and Internet service providers, most on-line services use a graphical user interface (GUI). GUIs utilize picture-oriented symbols (icons) intended to speed up the process by which a new user can learn to navigate the system; these icons perform the same functions as computer commands and control bars. For example, if users want to read their mail on AOL, they double click on the mailbox icon and a list of new messages will appear.

Another main benefit all on-line services offer is access to forums where users can discuss a wide variety of subjects. Usually, there are a number of different forums, broken down by category and level of interest. For example, the Parenting forum on AOL discusses such topics as introducing solids to infants, educational issues, and how to talk to a teen. The Public Relations forum on CompuServe talks about job hunting, how to use the Internet, and various industry issues.

Other on-line service benefits include live chat rooms where members can “meet” and talk in real time. Members type in messages that others can view and respond to immediately. Many services have large, “auditorium-like” discussion areas that offer extensive meetings with guests ranging from politicians to rock stars.

Most on-line services also have areas where users can search current and back issues of magazines and/or large databases of articles. The search usually involves the use of a keyword or phrase to describe what the user is looking for. Some magazines offer additional member services such as reduced subscription costs, on-line address changing and ordering, and areas where readers can discuss articles with writers and editors.

Many services also offer users the ability to download shareware programs and updates for computer programs they already own. Computer software and hardware manufacturers frequently have areas on several on-line services where users can go to ask for technical support or find out more details on their products. Shareware manufacturers use on-line services and BBSs as their main source of distribution. Some examples of shareware programs include games, graphics, word processors, business extensions, and spread sheets.

The most recent addition to on-line services has been Internet access. Most of the major services have been offering Internet and internal E-mail for the last few years. But as the Internet has become more and more popular, on-line services have been slowly upgrading the amount of Internet access and support available through their networks. Currently, the five largest on-line services provide access to Usenet groups (forum-like discussion areas that users subscribe to), mailing lists, Gopher (an intelligent computer program that finds files on remote computers and downloads them to the user’s system), and Telnet (users can log-on to the computers and run programs on the host system) sites. Some, including Prodigy, Delphi, and CompuServe, already have access to the fastest growing part of the Internet, the World Wide Web (WWW). The WWW connects sites together using hypertext links and is the first part of the Internet to use multimedia. By the end of 1995, most of the other on-line services will begin offering the Web to their users.

While most on-line services offer similar benefits, their cost structure and membership base can vary greatly. For example, CompuServe, owned by H&R Block and the oldest on-line service, is geared toward the needs and financial considerations of the business user, and this is reflected both in its content and pricing structure. On the other hand, both Prodigy, owned jointly by Sears and IBM, and America Online attract many family-oriented users, and their prices are structured accordingly. GEnie, owned by General Electric, and Delphi, owned partly by the FOX television network, focus on the needs and interests of more technically-oriented users.

Recently, many long time on-line services users have been switching to Internet service providers. Whether this trend will continue remains to be seen. But on-line services in general will continue to attract new users who want quick and easy access to information as well as convenient access to the Internet.

u contributed by JDC Editorial Staff

Optical Character Recognition (OCR)

The process by which computers can “read” printed text and graphics. OCR converts documents into electronic formats for display and/or modification. The converted document is stored inside the computer’s memory as a text, or simple binary coded document. OCR requires a combination of hardware and software resources for translation.

Teaching a computer to read is no simple task. Humans take reading for granted. They learn to recognize letters by deciphering what they see and comparing it to past experiences. A computer’s memory, however, is not able to translate past situations into today’s needs. But OCR technology allows the computer to save images for later retrieval and conversion. As a document is entered into the computer, OCR will find similar patterns and convert the text based on similar past performances.

The first step in the OCR process is to electronically enter text into the computer’s memory. This can be done using either a scanner (a handheld or stand alone input device) or a fax/modem connected to a computer.

Unlike humans, a computer “sees” printed text as a series of dots on a page. Scanners and fax machines convert printed or written text into an image of black and white areas called a bitmap.

After the bitmap is entered, it is sent into the computer’s memory, where translation begins. The OCR software program draws an imaginary box over each individual group of dots. The OCR program then compares the group’s characteristics to those saved in the computer’s memory. Each font, or style of text, has its own set of physical properties, such as straight lines, circles, and semi-circles. When the software finds a match, the pattern is translated into a letter (a,b,c), picture (an object, photo, design), or punctuation mark (“,!?). Depending on the type of program, the OCR software may or may not recognize other symbols, such as underlined text, bold lettering, and graphical elements (<,^,$). The OCR software may also have problems storing the decorative elements of a specific font. A highly complex “A” will either fail to be recognized or turn into a generic “A.” If the pattern is unrecognizable, the program will put an editing symbol (@,!,*) in its place.

Translation of patterns into characters is done by a set of mathematical algorithms. An algorithm is similar to a recipe. The algorithm tells the OCR program what to look for and how to translate it into something recognizable.

There are hundreds of different fonts commonly used in today’s computers. Because it’s impossible to teach OCR programs to recognize all of these fonts, most OCR software comes with a second set of algorithms known as Omnifonts. The Omnifont allows the main program to learn new characters. The conversion procedure is the same, except that the computer will prompt the user to define an unrecognizable pattern. After that, the program will attempt to translate the character on its own.

Most OCR software programs convert the document into an ASCII or text file. ASCII, which stands for American Standard Code for Information Interchange, contains all 256 characters used to store computer data. These characters include letters, numbers, punctuation marks, and graphic building blocks (¬, Δ, Σ). After the document is saved in ASCII, the user can import the document into a favorite word processing, spreadsheet, or desktop publishing program.

Unfortunately, OCR technology is far from perfect. Typical translation error rates remain around 10%. That means, on average, 10 characters out of 100 will be incorrect. The user will have to review the document, character by character, and correct lettering as needed. A spell checker, a software program that notes words it doesn't recognize, will find the obvious mistakes like "cct" for "cat," but not "cut" for "cat." Most spell checkers are designed to find spelling errors but not contextual errors. Therefore, careful proofing is required if 100% accuracy is needed.

OCR programs are most successful when used to read clear text. To increase accuracy, users should avoid decorative fonts, smudged manuscripts, and justified text. Original documents with simple fonts and evenly spaced letters are the best. Handwritten documents are very difficult for OCR programs to read and translate. These handwritten documents usually have the most translation errors. Many users have found that it is faster to type in a handwritten sheet than to scan it and correct the errors.

As OCR technology continues to develop and improve, it will be used more often. The end goal of OCR technology is 100% accuracy, but it is doubtful that goal will be achieved soon.

u contributed by JDC Editorial Staff

Output Devices

Equipment that enables the computer to provide information.

Output devices allow a computer to provide its user with information. The most common output device is the video display terminal (VDT), or monitor, which enables the computer to display its work on a screen. Another output method is the printer . It can produce a “hard copy” of what the computer has displayed on the screen, or of selected data, or of an entire document. In addition, voice synthesizers and sound cards let the computer communicate with users through synthesized speech. Combined with sound cards and monitors, optical disk drive drives can produce output in the form of audio, video or text. Modulators-demodulators, or modems, serve as both an output device and an input device (even simultaneously). As an input device, a modem converts analog tones into digital signals that a computer understands. As an output device, it converts the computer’s digital signals into analog tones that can be carried over the public switched telephone network (PSTN).

u contributed by Christopher LaMorte

Pacific Telesis Group (PacTel)

The regional Bell operating company (RBOC) — also known as a Baby Bell — that provides local telephone service in Nevada and California, as well as long-distance access, directory publishing, cellular and other information services.

Pacific Telesis Group (PacTel) is one of seven regional Bell operating companies (RBOCs) — also known as Baby Bells — created by AT&T's 1984 divestiture. PacTel received rights to provide local telephone service in Nevada and California, to retain a one-seventh interest in Bell Communications Research (Bellcore), and to provide directory publishing and cellular services. The communications giant is appropriately headquartered in San Francisco, which was the site of California's first telephone exchange in 1878 and was one end (New York City was the other) of the first transcoastal telephone call in 1915.

Following the 1984 breakup of AT&T, Pacific Telesis Group was faced with lingering poor relations with the California Public Utilities Commission (CPUC) that had erupted in the early 1980's between the CPUC and Pacific Bell. After the divestiture (when Pacific Bell became part of PacTel), the CPUC directed the company to make substantial customer refunds instead of granting a requested rate hike. While grappling with these issues and continuing to enhance its product offerings with services such as completion of calls initiated through directory assistance requests, PacTel began to focus on expansion into unregulated areas. Under the leadership of Philip J. Quigley, who became CEO in 1988, PacTel has aggressively pursued market opportunities emerging with rapidly developing communications technologies.

By the mid-1980's, PacTel had begun to expand its cellular activities. For example, it purchased a company with 5 cellular and 14 paging operations outside its territory. In 1991, the company combined its cellular operations in San Francisco, San Jose, Dallas and Kansas City with those of McCaw Cellular. To provide more latitude from regulatory restrictions, PacTel split its telephone and cellular businesses in 1992. With the 1994 spin-off of AirTouch Communications (formerly PacTel Cellular), however, PacTel effectively ended its domestic cellular business. Subsequently, AirTouch formed alliances with RBOCs U S WEST, Bell Atlantic and NYNEX.

In 1993, Pacific Telesis filed four video dialtone (VDT) applications with the Federal Communications Commission (FCC). VDT refers to the technology that enables immediate consumer access (similar to local telephone service access) to programming and interactive services including distance learning, home shopping, video games, community information and on-demand movies and television shows. On-demand is the industry term for technology that allows consumers to view selected programming at any time. PacTel's VDT plan includes initially providing services to over one million homes in the San Francisco, Los Angeles and San Diego areas. The company is working with Hewlett-Packard on systems to bring the products to California telephone customers. In collaboration with the *Los Angeles Times*, PacTel is also developing interactive shopping services that feature electronic business directories.

Moving into yet another arena, Pacific Telesis Group established a partnership with RBOCs Bell Atlantic and NYNEX in 1994 to deliver home entertainment, information and interactive services. To produce original programming, the consortium also formed a strategic relationship with Creative Artists Agency, Inc. (CAA). The technology side of the initiative will develop the systems necessary to deliver programming over the participating telephone companies' VDT networks. Other PacTel ventures connected to consumer entertainment include a project with Sony to bring movies into theaters using fiber optic cable, and PacTel's majority ownership of a Chicago cable television franchise.

In the education field, PacTel is investing $100 million to better equip students and others to travel the communications superhighway. In part, the monies will fund computer networking and video conferencing for over 7,000 California schools, libraries and community colleges. The company has also made $2.6 million of its services available to teams of San Francisco area businesses, schools and agencies. These teams are collaborating to develop innovative ways for their communities to effectively use PacTel's telephone network.

Internationally, Pacific Telesis Group is working with several Japanese companies to construct a trans-Pacific fiber optic cable. PacTel is also part of a group licensed to supply Germany with a cellular phone system, and owns a major interest in a Swedish cellular provider.

In addition to exploring these current market opportunities, PacTel continues to legally challenge provisions of the federal cable act that prohibit telephone companies from participating in video operations. As the result of similar court actions by RBOC Bell Atlantic, a federal district court in Virginia has ruled that Bell Atlantic may begin offering television programming in its service territory. Although the case is in the appeal process and the decision does not currently affect other telephone companies, PacTel is pursuing initiatives in this field in anticipation of positive outcomes from its legal actions.

PacTel has also made a $16 billion investment in upgrading its services and facilities. Among the company's planned infrastructure improvements is the wiring of five million homes with optical fiber by the end of the decade. Called *California First,* this PacTel initiative will create sophisticated telecommunications systems to deliver voice, data and video services in its most populous service area.

u contributed by Susan P. Sanders

Quigley, Philip J. (1943 –   )

American business executive, currently Chairman, President and Chief Executive Officer of Pacific Telesis Group, a regional Bell operating company (RBOC).

A native of San Francisco, Philip Quigley earned his Bachelor of Science degree in business from California State University in Los Angeles.

In April 1994, Quigley was named Chairman, President and Chief Executive Officer of regional Bell operating company (RBOC) Pacific Telesis Group (PacTel), and Chairman of its largest subsidiary, Pacific Bell. He held both positions until July 1, 1994, when Pacific Bell elected new officers.

Prior to assuming PacTel's top job, Quigley served in a number of senior management positions with the company, including Executive Vice President and Chief Operating Officer of PacTel Corporation and Chief Executive Officer of PacTel Personal Communications, the company's cellular and paging subsidiary at that time.

In a speech delivered in February 1990, to the Western Communications Forum, Quigley spoke of his vision for corporations that will be able to remain competitive in times of rapidly evolving technology and fierce competition for customer loyalty. The speech centered around the debate concerning effectiveness of large corporations versus smaller start-up operations. He likened the large corporations to elephants — strong, but lacking agility. The rabbit — possessing agility, but little strength — was his metaphor for smaller businesses. Quigley suggested that corporations need not choose one over the other, but could instead become a hybrid — the "rabbiphant."

To create a "rabbiphant" at Pacific Bell (which he headed at the time), Quigley was building an environment that encouraged individual responsibility and fostered a sense of ownership and involvement for all employees. Twenty-first century employee communications was the way he summarized Pacific Bell's plan for the future. That plan, said Quigley, would enable businesses to successfully meet the greatest challenge they face — to "show the customer what benefits you can deliver and what technology can do to improve the quality of life…for that challenge, neither elephants nor rabbits will be able to compete with the rabbiphant."

Philip J. Quigley's vision and leadership are a vital asset at Pacific Telesis and sought after by other organizations. He was elected as a Director of Wells Fargo Bank in May 1994, and also serves as Director for the California Chamber of Commerce, California Business Roundtable and Varian Associates.

u contributed by Susan P. Sanders

Packet Switching

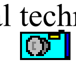
A process that allows computer and telephone networks to transfer information from one user to one or many users. The data to be transmitted is broken up into a series of chunks known as packets, frames or cells. The packets (frames or cells) are sent individually through a specialized network until they reach their final destination. Once there, they are reconfigured into the original data. Packet switching, used in computer networks, provides an alternative to circuit switching, used in voice networks. Together they represent the only methods of switching.

Computer networks connect devices that have very different communications requirements than do telephones on voice networks. Data calls and voice calls differ in how each deals with, and has requirements for, bandwidth, noise, delay, errors, reliability and other factors. For these reasons packet switching was developed.

Packet switched data is broken up into fixed or variable-sized packets, error checking codes are sometimes added, the addresses are appended, and then the packet is sent, along with many others, across a specialized network. Asynchronous Transfer Mode (ATM) uses a fixed packet length of 53 bytes. ATM packets are called cells. Frame relay, a technology used in across-town and across-the-nation communications, uses variable length packets, called frames. Token ring and Ethernet, two popular local area network (LAN) technologies, use yet other packet schemes. In all cases, packet switching provides a method for a network to efficiently connect many computer users.

The packets of data may need to go through several hardware connection devices before reaching their final destination. Special packet switches, or routers, read each packet's destination addresses and route the frame to the next packet switch or to the recipient, if possible. Devices called gateways may be necessary between network providers to send a packet from one network to another. Packets on LANs have to be translated into ATM or frame relay packets before transmission over wide area networks (WANs). Sometimes, packet switches pick the shortest path from sender to receiver, and sometimes they just find a path that will work. For example, in LAN environments, there usually is only one path between two computers, whereas in WANs, often there are several paths provided by redundant connections. The network hardware and software manages all network connections and intermediate nodes.

Packet switching allows the efficient use of one, or a few, physical connections, such as wire pairs, to support many logical connections. This is done by sending many packets, from many users and to many users, using time division multiplexing (TDM), over a single or several connections. The network figures out where the packets need to go. Unique network addresses are the key to this technology.

Packet switching also has the benefit of using digital technology. Computers are used to create packets, check data, and route transmissions  . As a result, data transmissions using packet switching, when compared to using modems and connections from the public switched network (PSTN), have fewer errors, use available bandwidth more efficiently and are provided at a lower cost per rate of traffic.

Today, developers are designing new ways to use packet switching with cellular, personal communications services (PCS), and low earth orbit (LEO) satellite systems. With the increasing use of computers in society, packet switching will remain a crucial part of computer networking.

u contributed by Mark W. Easland

Pagers

Small, portable electronic devices that can receive and send messages through various wireless networks.

Developed in 1971 by Motorola, Inc., early pagers enabled people to be signalled to call their office for a message. Originally, pagers were believed to be necessary only for doctors who were on call and could be urgently needed at the hospital or their office. From simple beeping devices, pagers have developed into sophisticated communication devices that can be used for one- or two-way communications and messaging.

A paging system is a form of wireless communication that receives radio frequency signals transmitted by antennas. Encoded messages from a telephone or computer are sent to antennas over the public switched telephone network (PSTN) or over satellite networks.

Individual pager receivers are assigned a specific code, much like a telephone number. When a caller wants to signal a pager, the message is converted by an encoder into a format that can be transmitted to the pager. The signal is then carried by ground- or satellite-based network antennas and broadcast on a radio frequency to a special receiver in the pager. Depending upon the service and type of pager, the caller can send a simple tone, a telephone number, a short voice message or a text message from a personal computer or computer terminal. Satellites are used to interconnect the antennas in nationwide paging networks; however, current pagers do not receive signals directly from satellites.

The pager itself is a small, battery-powered, lightweight receiver that can be carried in a pocket or worn on a belt. Pagers come in four types:
u *alert*, which signals the receiver with a beep, vibration or light;
u *tone and voice*, which notifies the receiver of a message and plays a voice message;
u *numeric*, which receives numeric information, such as a phone number, that is keyed in on the telephone; and
u *alphanumeric*, which can receive a complete text message.
Pagers can be either analog or digital, with digital pagers often being used for the more sophisticated services that allow full-text messages to be received.

In the future, personal communication services (PCS) and personal digital assistants (PDAs) will either receive and transmit directly to a satellite in low-earth orbit or to new ground-based antennas. These advanced communication devices, which will have far more capability than current pagers, or even telephones, will revolutionize the portable communications industry.

The Federal Communications Commission (FCC) has reserved specific radio frequencies for paging and messaging services. The FCC allows some frequencies to be used for local paging, others for regional or national paging. Paging frequencies typically have a bandwidth of either 12.5 megahertz (MHz) or 50 MHz, depending on the type of service that will use the frequency and whether it is one- or two-way. Some pagers scan frequencies available in a geographical area and use a frequency that is open, and they can change frequencies from city to city as the receiver moves about the country.

Today, low-power, micro-cell pager systems are used in small areas, such as office buildings, to maintain contact with an office. These low-power pagers are also becoming popular in restaurants to notify customers when a table is available. This allows customers to be off the premises, yet know when to return. Pagers are also used by cooks to tell servers that an order is ready, and by diners to beep their server. In a retail setting, Super K-Mart Stores are giving salespeople pagers so customers can page them for assistance in a given product area.

In addition to the obvious business uses, pagers are a convenient form of communication for many people. Among its numerous uses, a pager can keep parents and children in contact when a telephone is unavailable; a pager can receive coded signals for frequently transmitted messages, such as “stop at the store on your way home and pick up a loaf of bread”; and pagers can he used by pregnant women to let fathers know that “it’s time.”

Advancements in paging technology have enabled manufacturers, such as Seiko and Timex, to build paging devices into wrist watches. Some pagers have built-in memory that can hold dozens of messages, allow the user to scroll through individual messages and identify each message with the time and date it was received.

Paging services have become a big business in the United States and are expected to grow tremendously in the next few years. In 1994, when the FCC auctioned 10 licenses for nationwide radio frequencies for paging services, companies paid $617 million for the licenses. One company, PageNet, Inc. (formerly Paging Network, Inc.) paid $197 million for 3 licenses, intending to offer a service to its 4.8 million subscribers that would expand the pager into a portable answering machine.

Since the invention of the telephone in 1876, people have gradually fallen in love with the immediate communications it offers, and in some cases have become obsessive about never missing a call. Pagers have allowed people to step away from the telephone, yet still feel connected.

u contributed by Paul Stranahan

Paley, William S. (1901 – 1990)

American businessman and television executive, primarily known for 60 years of successful leadership of the Columbia Broadcasting System (CBS) and often called the father of modern broadcasting for his contributions to the industry.

Paley was born in Chicago, Illinois in 1901. His family owned a prosperous cigar business there and groomed him from an early age to take it over. He was educated in the Wharton School of Finance at the University of Pennsylvania and received his BS in 1922. He then worked at every level of his family's new cigar firm in Philadelphia. In 1925, his experiment with using radio advertising boosted the cigar business immediately and convinced Paley of radio's great potential to reach consumers.

This led him in 1927 to purchase a struggling radio network called the Columbia Phonograph Broadcasting Company. Its chief competitor was the National Broadcasting Company (NBC), whose parent was the enormously powerful RCA. Moving to New York, Paley assumed the company's presidency in 1928 and immediately convinced almost 50 stations to join the network by offering them free programming.

The next year, Paley renamed the company Columbia Broadcasting System (CBS) and also formed the Columbia Concerts Corporation, an agency to recruit and book performers for CBS programs. His novel idea of providing free programming to affiliates proved very popular. By 1934, CBS boasted 100 affiliates and over $2 million in profits from advertising revenues.

Also in the 1930's, Paley purchased Columbia Phonograph and Records Company and in 1938, the American Record Corporation. Combined and later known as CBS Records Division/Columbia Records, this new entity would become the most successful recording company in the world, helped along by CBS Laboratory's invention of the revolutionary 33 1/3 rpm long-playing record in 1948.

During World War II, both Paley and CBS played important roles in the war effort. Paley first supervised the Office of War Information (OWI) for the U.S. government in the Mediterranean and later served as Chief of Radio Broadcasting with the Psychological Warfare Division in England. As President of CBS, Paley encouraged the network's outstanding coverage of war events in a daily program entitled *CBS News World Roundup*, featuring such prestigious and popular correspondents as Edward R. Murrow, Eric Sevareid, and Charles Collingwood, among others.

Over the ensuing decades, Paley led CBS to greatness in both radio and television with his aggressive leadership and astute understanding of what would entertain the American public. He shrewdly built up the CBS news and public affairs divisions, notoriously raided the other networks for their most popular stars, and produced such popular and enduring shows as *I Love Lucy*, *Gunsmoke*, *Playhouse 90*, and *The Ed Sullivan Show*.

At age 65, Paley waived CBS's mandatory retirement rule so he could maintain active control as Chairman of the Board, which he did for 17 more years. When he retired in

1983, the company's revenues exceeded $4 billion per year. After a corporate shakeup in 1986, however, Paley returned as acting Chairman. During his final tenure, he shared control of CBS with Lawrence "Larry" Tisch, head of the Loew's Corporation, and his family.

Paley married Barbara "Babe" Cushing in 1947 and they became leaders in New York society. For many years, he was active in the Museum of Modern Art and held the positions of Trustee and President. He also founded the Museum of Broadcasting in New York in 1976.

William Paley died in New York City in 1990, after running CBS for more than half a century and acquiring over 40 other companies during his tenure. Considered a broadcasting genius, Paley is often credited with the incredible boost in the popularity of television after World War II and CBS's prominence as a network for decades.

u contributed by Kay S. Volkema

Parsons, LeRoy E. "Ed" (1907 – 1989)

American cable television pioneer, radio station owner, electronics engineer, consultant, commercial pilot, airline executive, entrepreneur and writer. "Ed" Parsons is best known for the cable television system he built in Astoria, Oregon, in 1948.

LeRoy Edward "Ed" Parsons was born on January 28, 1907, in Latourelle, Oregon. Following high school, he attended a number of engineering trade schools. He began his career as Chief Engineer for the Bridal Veil Timber Company, where he worked for 10 years. From there, he moved to the Harris Machine Works of Oregon. In 1942, he purchased radio station KAST in Astoria, Oregon, a small community only 60 air miles from Seattle, Washington.

In his efforts to fulfill a promise to his wife that he would get her a television set as soon as one was available, Ed Parsons made history by establishing one of the first cable television systems in the country. This was at the same time that early cable television systems were being created in Lansford and Pottsville, Pennsylvania.

In 1948, Parsons purchased a television set as promised. However, due to the mountainous terrain surrounding Astoria, the television set could not receive any traditional broadcast signals. Because of his knowledge of electronics, Parsons determined that if he could somehow build an antenna to receive television signals from KRSC-TV in Seattle, he would be able to divert the signals to the television set in his home. KRSC-TV had just begun broadcasting during the summer of 1948.

He set about the task of finding a suitable location, and soon found that the best spot in Astoria to receive the signal was on the roof of the John Jacob Astor Hotel. Parsons was given permission to place an antenna on the hotel's roof. With his wife assisting him, and communicating with her via walkie-talkie, Parsons adjusted the antenna so that he could receive KRSC-TV's signal on one channel and re-direct it to his home television set on another.

Needless to say, as the only home in the small community of Astoria with a working television set, their residence quickly became the most popular location in the area. So much so that Parsons soon wisely connected a television set in the lobby of the hotel and one across the street from the hotel in the window of Poole's Music Store.

His cable business began to grow dramatically…and by May 1949, he was installing 20 sets per month for a fee of $100 per installation. Because his initial goal of providing television service for his wife had grown into a community-wide business, Parsons requested re-transmission rights from KRSC-TV. The station manager in Seattle gave Parsons permission to retransmit the station's signals if Parsons agreed to several conditions. The most noteworthy of these was that the station manager could revoke permission at any time.

Shortly thereafter, the American Society of Composers, Authors and Publishers (ASCAP) notified Parsons that he would have to pay the organization for any music retransmitted on his Astoria cable television system. In response to the organization’s demands, Parsons, who owned a radio station, declared that all ASCAP music was prohibited from being played on his radio station. Soon after learning of this decision, ASCAP withdrew its demands for Parsons to pay royalties, and Parsons’s station began playing ASCAP-licensed music once again.

Parsons’s original cable system was acquired in 1953 by a group of 13 businessmen and professionals from Astoria. In 1954, this group sold 50 percent of the company to cable television investors from Seattle and Aberdeen, Washington. In 1964, Cox Cablevision Corporation purchased the entire operation.

Parsons later founded Communications Supply, Inc. and then served as Communications Engineer/Assistant to the President at Wien Airlines for 12 years. Following his tenure with Wien Airlines, he worked as Sales Manager/ Field Engineer for Northern Radio Company of Seattle. In addition, Parsons was certified as a commercial pilot. He was recognized in articles in *The Last of the Bush Pilots*, *The Great Land* and *Alaska Today.*

His other accomplishments include his work in building, in cooperation with the Scandinavian Air Force, the Alaskan leg of a communications system utilized for the initial commercial trans-polar flight. In addition, he assisted in the development and construction of the first Eskimo radio station in the United States. He was very involved in the development of a communications system in the Arctic and helped construct Husky Oil Company’s communications network, which was used in oil exploration efforts in Husky’s National Petroleum Reserve in Alaska. In addition, he also wrote a number of articles that were published in a variety of trade journals.

Also involved in the community, Parsons was Chairman of the President’s Commission for Hiring the Handicapped and was a member of the National Cable Television Association’s (NCTA) Cable TV Pioneer Club. The community of Astoria, Oregon, dedicated a lasting tribute to him with a monument built in his honor. Located on Coxcomb Hill at the base of the “Astoria Column,” the granite monument was dedicated in May 1968. A plaque on the monument states: “Site of first community antenna television installation in the United States completed February 1949, Astoria, Oregon. Cable television was invented and developed by L. E. (Ed) Parsons on Thanksgiving Day, 1948. The system carried the first TV transmission by KRSC-TV, Channel 5, Seattle. This marked the beginning of cable TV.”

Parsons passed away in 1989. He is survived by wife, Hertha, and three grown children.

u contributed by Valerie Switzer

Pascal, Blaise (1623 – 1662)

French mathematician, physicist, theologian, and inventor of the world's first automatic calculating machine, the *Pascaline*. The computer language Pascal is named in his honor.

Born in 1623 in central France, Pascal and his family moved to Paris after his mother's death six years later. Educated by his mathematician father, Pascal proved to be a child prodigy. In his mid-teens, he formulated one of projective geometry's basic theorems. Together, the two Pascals conducted experiments that eventually led to the invention of the barometer, hydraulic press and syringe. Pascal proved that pressure is transmitted equally through a fluid in all directions, a discovery now known as Pascal's law or principle.

In 1642, at the age of 20, Pascal invented the first automatic calculating machine, originally designed to assist his father's accounting. He patented it in 1647. Until the age of 30, he worked to further perfect the *Pascaline*, trying various materials and constructing more than 50 models. He and his father attempted to market the invention, but could not overcome its reliability and service problems. As the first automatic calculator, however, the *Pascaline* brought fame to its inventor throughout Europe and stimulated his philosophical writings, further increasing his fame.

In 1654, working with French mathematician Pierre de Fermat, Pascal developed the mathematical theory of probability. Later that year he had a self-proclaimed religious experience, and thereafter devoted himself to religious philosophy. His cause was Jansenism — a Roman Catholic reform movement — that his sister Jacqueline also espoused. His writings on the subject of theology are considered masterpieces. In 1662, Blaise Pascal died in Paris at the age of 39 from a malignant stomach ulcer.

u contributed by Kay S. Volkema

Pay-Per-View

A cable service that allows viewers to purchase movies or special events on a per-feature basis.

The cable television industry has always prided itself on its ability to provide a wide array of viewing choices to customers. Pay-per-view channels have been one way it has been able to do so.

Pay-per-view allows viewers to pay for only the movies or special events that they want to see. Cable companies offering pay-per-view services send scrambled signals to their customers, and those who agree to pay a fee for the programming have the picture unscrambled for them. A special type of cable box — called an addressable converter — enables the cable provider to send the unscrambled signal only to those who pay for it. Currently, 33 million American homes are equipped with addressable converters.

Pay-per-view is especially attractive to those who like to see an occasional movie or sporting event but do not want to pay a monthly fee for a premium cable channel that offers this type of programming on a regular basis. Instead, the viewer chooses to pay for a selected event.

Though cable and other pay-television services offered pay-per-view options to viewers beginning the late 1970's, it wasn't until 1985 that the Request Television and Viewers Choice networks began offering regular non-sports related pay-per-view programming, such as movies and concerts.

Pay-per-view channels offer popular movies on the average of six to nine months after they have been released in the theater and before they appear on premium cable channels. For a price that rivals video cassette rentals, viewers with an addressable converter can order the movie using their telephone or even the converter box or its remote control.

Though recent films have become the most common offering on pay-per-view channels, the revenue they provide does not compare to special events, particularly sporting events like boxing. For example, two Evander Holyfield fights (against Buster Douglas in 1990 and against George Foreman in 1991) created $85 million in pay-per-view revenue. *Wrestlemania*, featuring the flamboyant superstars of the World Wrestling Federation, such as Hulk Hogan, generated $13 million.

Part of the reason that even blockbuster movies do not frequently generate more than $1 million in pay-per-view revenues is because the films are often rigidly scheduled at designated start times. Though pay-per-view movies boast certain advantages over video store rentals, such as offering viewers the ability to see uncut movies without leaving their home, pay-per-view does not offer the flexibility of videocassettes. Viewers cannot decide when to watch the movie, nor do they have the control a VCR provides such as pause, rewind and fast forward.

In an effort to make pay-per-view more convenient, cable companies have experimented with enhanced pay-per-view services. These systems offer many channels with the same movie but with different start times so that a viewer can choose a time when it is personally more convenient to watch.

Some have argued that pay-per-view is a threat to broadcast television. They feared pay-per view would cause people to pay for events they were used to seeing for free on network television. In 1993, interim Federal Communication Commission commissioner James Quello said that pay-per-view is “inherently a natural enemy of free TV.” He added that pay-per-view could create a disparity in television access between the poor and rich if viewers are required to pay for an increasing amount of programming.

u contributed by Christopher LaMorte

PCMCIA cards

Barely larger than a credit card, PCMCIA cards are the major component of what is becoming known as “plug and play” technology. Combined with the appropriate software, these small peripherals provide an easy, flexible method of adding features to a computer system without opening the case of the system or turning it off.

PCMCIA (Personal Computer Memory Card International Association) cards, also known as PC cards, are credit-card-sized computer peripherals used to add memory or other devices, such as modems, fax cards, hard disks, and network connections, to computer systems. With the appropriate software, they can be used on computers ranging in size from desktop systems to hand-held devices, although they are most commonly found on laptop or notebook personal computers.

PC cards, as well as the sockets they plug into, are classified as Type I, Type II, or Type III. They are all the same size, measuring 69.2 millimeters (3.37 inches) by 51.45 millimeters (2.126 inches), and they all use the same type of pin connector for attachment to a computer. However, they vary in thickness depending on the technology they contain, ranging from Type I memory cards, the thinnest at 3.3 millimeters, to 10.5 millimeter Type III cards that are thick enough to contain 260-megabyte hard drives. The thinner Type I and Type II cards are also often used as card interfaces to portable computers for such peripherals as external floppy-disk, hard-disk and CD-ROM drives.

Two pieces of specialized software are required to operate PC cards. First, access to a computer’s PCMCIA sockets must be established through Socket Services. This software, which interacts with the computer’s basic operating system, identifies the number of PCMCIA slots in the computer system and detects the presence of a PC card when the system is in use.

Once Socket Services detects that a PC card has been added, another specialized software program called Card Services automatically manages allocation of system resources, including hardware configurations, memory, and interrupts. When the PC card is removed, Card Services returns these resources to the host computer.

PCMCIA hardware and software are major components of what is becoming known as “plug and play” technology. Once Socket Services and Card Services are installed in a computer system, users can insert or remove PC cards while the system is running, and exchange cards with different functions without shutting the system down. PCMCIA software also automatically configures the host computer system, eliminating the need for installing or configuring software drivers or other devices when PCMCIA-based peripherals are added.

PC cards are primarily used for general memory enhancement and additional functionality, making them an ideal choice for adding large software applications to computers on either a temporary or permanent basis. For example, physicians can plug PC memory cards containing specialized medical software into hand-held computers for access to medical records, drug information and automated lab result retrieval. Databases, digital books and other reference materials are now being developed for distribution with PC memory cards as well.

u contributed by Sonia Weiss

Pender, Sir John (1816 – 1896)

British millionaire industrialist and member of Parliament who was instrumental in assisting Cyrus W. Field in the completion of the trans-Atlantic telegraph.

John Pender, born September 10, 1816, was the son of James Pender of the Vale of Leven, Dumbartonshire, and Marion Mason. He was educated at the High School of Glasgow, where he received a gold medal for design. After a successful career as a textile merchant in Glasgow and Manchester, he made the expansion of submarine telegraphy his principal interest.

Pender was one of the original 345 contributors to the first Atlantic Cable Company in 1856. Each contributed £1,000 towards the expenses of the company's attempts to lay a transatlantic telegraph cable. As a director of the company, Pender shared in the failures and disappointments which dogged the company for eight years. Pender was not alone in his efforts. Between 1861 and 1864, American Cyrus W. Field was traveling between England and the United States, trying to convince capitalists that their next effort to complete the transatlantic telegraph would not fail.

In 1858, Field had succeeded in laying a telegraph cable across the Atlantic, but the cable failed after 732 messages. With the Civil War raging, the United States had little energy or spirit for such a project. Additionally, relations between England and Washington, D.C., were still strained by the declaration of neutrality of May 14, 1861, in which the Confederacy had been granted the rights accorded a sovereign nation. Field's tact and remarkable powers of persuasion must have been used to their fullest as he shuttled back and forth across the Atlantic.

It took more than two years to get things moving again, and this time the project was largely financed and wholly carried out by Great Britain with only one-tenth of the capital coming from the United States. On April 7, 1864, and under the influence of Pender, a member of Parliament, the two contractors who collectively had the greatest experience in submarine cable manufacturing merged into a single company. Until that time, cable core and insulation had been manufactured exclusively by the Gutta Percha Company, and the protective covering had been largely made by Messrs. Glass, Elliott & Company. They now formed the Telegraph Construction and Maintenance company, which still exists and which, with its associates, has now made more than 90 percent of the submarine cables in the world.

With Pender as Chairman of the new firm; John Chatterton, inventor of an insulating material; Willoughby Smith, a famous electrician; and R.A. Glass, managing director, the new company was so confident of success that it immediately committed £315,000 of capital and £100,000 in bonds to the project. Although Field himself raised £285,000 from investors, the enterprise had such a British complexion that the *Encyclopedia Britannica* did not mention Field's role in the project until its 1910 edition.

Despite securing the necessary capital, Pender and his group faced another daunting task, that of transporting the cable across the Atlantic. The cable that was to be used for this venture was twice as heavy as the cable used in Field's 1858 transatlantic attempt that had loaded two ships to capacity. As if by magic, the *Great Eastern*, a large merchant ship, appeared. Since the ship was idle and unwanted, it was easy to convince Daniel Gooch, the ship's owner, to commit to the enterprise. Gooch had a sentimental streak and believed that the enterprise and the ship were meant for each other. He only asked to be rewarded with £50,000 of cable stock if the undertaking was successful. On July 25, 1866, the *Great Eastern* successfully arrived off Heart's Content, Trinity Bay, Newfoundland, with the cable.

After the successful laying of the transatlantic cable, Pender directed his energies to other telegraph companies and the linking of Great Britain's Asiatic and Australian possessions as well as the cables of the Eastern and associated companies surrounding the African continent. In his later years, Pender's skills as an organizer and administrator were put to good use as the Chairman of the Metropolitan Electric Supply Company and its undertaking to electrically light London.

Pender sat as liberal member for Totnes in 1865 to 1866, but was unseated on petition. From 1872 to 1885, Pender was a liberal member for the Wick district. A Liberal Unionist from 1892 until he resigned in 1896, Pender was in favor of a local self-government for Ireland as well as for the rest of the United Kingdom. In 1888, in recognition of his services to the empire, Queen Victoria made him a K.C.M.G. at a banquet given in his honor, and in 1892, he was promoted to a grand cross of the same order. Pender held many foreign orders, among them the Legion of Honour and the Grand Cordon of the Medjidie. He was also a fellow of the Imperial Institute, of the Royal Society of Edinburgh, of the Royal Geographical Society, and of the Scottish Society of Antiquaries.

u contributed by Diana L. Hollenbeck

Personal Communications Services (PCS)

A wireless voice and data network which connects users to other users via its own network resources, the public switched telephone network (PSTN) or cellular networks.

Personal Communications Services (PCS) is a combination of the technology used in computer networking and radio broadcasting. PCS uses radio frequencies between 120 Megahertz (MHz) and 2 Gigahertz (GHz) to send data and voice transmissions from one user to another.

Until recently, no one was certain exactly how PCS systems would be implemented. It now appears that there will be a number of PCS networks across the country. Each will send data through the airwaves over a specified radio frequency. Users will be able to send and receive information through the PCS network using specially designed hardware. A PCS network can transmit voices as well as written text. So not only will users be able to read their E-mail and exchange files, but they will also be able to use a PCS network to phone clients, friends, and family across the country.

PCS networks will be very similar to today's cellular phone networks. The main difference is what form the transmitted information takes. Rather than using analog transmissions, PCS networks will translate voice and data into digital signals. The quality of the transmission will be much better than what is currently available through cellular signals.

Speech will no longer have the tinny sound and constant break-ups that users often find in cellular service. The cost of PCSs will start out lower than cellular networks and is expected to drop rapidly as the number of users increases.

PCS is an industry in its infancy. However, most industry analysts believe that PCS will change the face of computer networking. In addition to having higher accuracy and lower cost than today's cellular service, the PCS network is relatively secure. Users requiring secure transmissions will find PCS especially attractive because hackers will have a hard time decoding digital information that they may pick up from the airwaves.

The Federal Communications Commission (FCC) started auctioning PCS licenses in May 1994. Since then, industry leaders have been competing for valuable frequency spectrum. PCS should be available to the general public by the end of 1996. Its hardware will include handsets, phones, and networking equipment. PCS is predicted to be widely used and accepted by the wireless telephone customer and mobile computer user by the late 1990's.

u contributed by JDC Editorial Staff

Personal Digital Assistants (PDAs)

Small, handheld personal computers that are portable and can be used outside an office environment. Many PDAs have liquid crystal display (LCD) screens and special electronic pens that allow users to handwrite information into the system. They may also connect to the Internet and other computer networks.

The first personal computers (PCs) were large, bulky machines. They were built to sit securely on desktops, plugged into a stable source of electricity, protected from dust, power surges, and various dangers that could damage their memory. Salespeople and other mobile professionals, therefore, could not utilize PCs to their fullest potential.

Eventually computers began to shrink in size, and PCs kept getting smaller and smaller. Then developers came out with the first laptop computer. Laptops were designed to fit in a briefcase and use batteries as an energy source. Those who frequently needed to work on the road loved laptops, but they still had a number of limitations. The charge from most batteries lasted less than a few hours, information still needed to be typed into the system, and even the smallest laptops weighed eight to ten pounds, making them hard to use for many organizational tasks.

In the late 1980's, several manufacturers came out with small, handheld computers known as personal digital assistants (PDAs). Some PDAs were small enough to fit into a pocket or purse. Several had an LCD touch screen that let users handwrite messages directly into the PDAs' memory. Theoretically, the PDA would be able to analyze the message using optical character recognition (OCR) technology and save the message as a file in the computer's hard drive. Other PDAs relied on a standard, or tiny, keyboard to input data.

Users could save messages, telephone numbers, or other information on the PDA. Some PDA software even recognized simple commands. For example, if a user wrote in "call home," the program would find the telephone number and prepare to dial.

PDAs could also connect to computer networks using regular telephone lines or cellular services. Users could download and reply to their E-mail, post messages to on-line discussion groups, or view files outside of the office. PDAs allowed users to pay bills electronically or keep watch on stock prices. PDAs could also send and receive faxes on the road. While many computer users were impressed by the wide variety of services a PDA could offer, those same users also struggled with its annoying deficiencies.

Currently, one of the biggest difficulties facing both users and manufacturers of PDAs is the machines' failure at handwriting recognition. Even under the best conditions, most OCR software has about a ten percent error rate. Without standardized, easy-to-read type, OCR programs have some difficulty recognizing what is being entered. Yet, few people can handwrite messages in such a standardized fashion. Consequently, words written into the PDA are rarely saved as they were intended, so what might potentially be one of the biggest advantages of using a PDA is so far more of a hindrance.

There have been a number of other problems as well. Since PDAs were designed to be as small as possible, most had no keyboards. Thus, data could not be easily entered and manipulated. The only way for a user to change text-based information was to connect a PDA to an external keyboard or computer.

Additionally, because PDAs had small amounts of hard drive space, their memory could be overloaded by several files or a received fax. To increase storage capacity, therefore, users needed to add an external hard drive. But most peripherals were bulky and hard to connect. The PDA with peripherals attached could wind up weighing as much as a laptop computer.

To decrease the size and bulk of hard drive space, manufacturers came up with a new type of peripheral and connection design. The name for the type of slots and peripherals was PCMCIA which stands for Personal Computer Memory Card International Association. This association was responsible for implementing standards and design specifications for a new generation of lightweight, power efficient, and fast hard drives and modems. What they came up with were small, credit card-sized devices, which were supposed to make computer expansion easy. Unfortunately, few manufacturers followed the guidelines. The result was poorly designed and hard to use products. After user outcry, manufacturers finally started working together, and the most recent line of PCMCIAs has been greatly improved. Most PDAs, laptops, and personal computers now offer PCMCIA slots.

Small modems were supposed to allow users to connect to the Internet and other on-line communication services. Unfortunately, most PDAs only had one or two PCMCIA slots. These slots could be taken up by extra storage space or battery packs.

Battery life was another problem. The first PDAs used alkaline batteries that lasted only an hour or so. Users needed to constantly recharge the system before the battery died.

Developers are now trying to make changes to PDAs that resolve their deficiencies. Some recent accomplishments include a software package that increases the accuracy of OCR and the addition of more PCMCIA slots for peripherals. Other changes include using rechargeable NiCad and other battery materials to increase amount of usage time.

There is market interest in PDAs, and may potential users look forward to the day when the system problems are solved. Once these limitations are addressed, PDAs will become yet another valued alternative for portable computing.

u contributed by JDC Editorial Staff

Pierce, John Robinson (1910 –)

American engineer, scientist, author, satellite communications pioneer, and holder of 90 patents.

John Robinson Pierce was born in Des Moines, Iowa, on March 27, 1910, the only child of John Starr and Harriett Anne Robinson Pierce. His parents were in the wholesale millinery business. After attending school in St. Paul, Minnesota, and Mason City, Iowa, he moved with his family to California, where he graduated in 1928 from Woodrow Wilson High School in Long Beach. While still in high school, he began to write science fiction, and his interest in this genre greatly influenced his subsequent career.

After graduating from high school, Pierce entered the California Institute of Technology (Cal Tech) in Pasadena to study chemical engineering, but he soon found that his abilities were not suited to this field. He then switched to aeronautics and ultimately to electronics. Cal Tech awarded him a BS in 1933, an MS in 1934, and a Ph.D. in 1936.

Upon completing his studies, Pierce accepted a position with Bell Telephone Laboratories (Bell Labs) as a member of its technical staff in New York, where he worked on high-frequency electron tubes, specializing in traveling-wave tubes. During World War II, Pierce was involved in the development of electronic devices for military use, and in 1946 he participated in a project at the Massachusetts Institute of Technology (MIT) in Cambridge, where he developed a radio navigation system, known as “loran,” for launching guided missiles.

In 1952, Pierce transferred to the Murray Hill, New Jersey, division of Bell Labs as Director of Electronics Research, and from 1955 to 1958 he was Director of Research in Electrical Communications. In 1958, he was named Director of Research in Communication Principles and was responsible for conducting research in radio, electronics, satellite communications, acoustics and vision, mathematics, and group behavior.

As early as 1954, three years before the Soviet Union placed the first man-made satellite into orbit, Pierce conceived of the possibility of a relay satellite that could greatly increase the capacity for global telephone communications and might ultimately make intercontinental cables obsolete. His proposals were published in the journal *Jet Propulsion* in April 1955. At a symposium on space communications held at George Washington University in Washington, D.C., in October 1958, he described three workable satellite systems and maintained that 25 satellites placed in polar orbits could provide almost continuous communications between continents.

When Pierce learned late in 1958 that the National Aeronautics and Space Administration (NASA) was experimenting with balloon satellites to measure atmospheric density at high altitudes, he promptly went to Washington. He succeeded in persuading government officials to divert this project’s direction into the development of a communications satellite, which would be of immense practical value. Soviet scientists had not yet been working in this intriguing area.

The project was started in 1959 with the aid of Dr. R. Kompfner, an Austrian-born physicist who was hired by Bell Labs largely through the efforts of Pierce. Finally, in the early morning hours of August 12, 1960, their first communications satellite, Echo I, was successfully launched into orbit by a Thor-Delta rocket fired from Cape Canaveral.

The largest man-made object ever placed in outer space, Echo I was an aluminum-coated plastic balloon weighing 136 pounds and with a diameter of 100 feet. It reflected radio-magnetic waves of frequencies up to 20,000 megacycles and circled the Earth every 121.6 minutes at altitudes ranging from 694 to 1,270 miles. It appeared in the sky as a bright moving star and was sighted by observers all over the world.

On its second journey around the Earth, about two hours after its launch, the satellite successfully relayed a taped message by President Dwight D. Eisenhower from the Jet Propulsion Laboratory station in Goldstone, California, to the Bell Labs station in Holmdel, New Jersey, 2,400 miles away. On the following day, two successful two-way telephone conversations were transmitted by Echo I. Pierce believed that such satellites could also be used to provide a reliable weather communications system and to bring about global radio and television transmission that would be unaffected by the curvature of the Earth or disturbances in the atmosphere. While enjoying some success, massive low earth orbit satellites, like Echo I, were replaced by active geosynchronous satellites.

Pierce has contributed considerably to the literature in his field. His 14 books include *Theory and Design of Electron Beams* (Van Nostrand, 1949 – 1954); *Traveling-Wave Tubes* (Van Nostrand, 1950); and *Electrons, Waves and Messages* (Hanover House, 1956). The latter, written for the general reader, attempts to show the close relationship of scientific theory to the everyday world. In cooperation with Dr. Edward E. David, Pierce also wrote *Man's World of Sound* (Doubleday, 1958), a history of acoustics research in which he introduced the reader to the new science of "psychoacoustics." He wrote a volume in the Science Study Series, *Waves and the Ear* (Doubleday, 1960). He has also written numerous articles for popular as well as scholarly journals and has contributed a number of papers to the *Proceedings of the Institute of Radio Engineers.* He is the author of several science fiction stories written under the pseudonym J. J. Coupling.

In his writings, Pierce has been concerned, not only with technical matters, but also with various general problems confronting the scientist. He once proposed that scientific conferences be held over closed television circuits in order to save scientists much valuable time. In an article for *Scientific American* (September 1958) he explored the relationship, differences, and similarities between pure science and technological innovation. He said that "in technology, as in science, the individual act of creation is the essential ingredient of innovation." In another article, he discussed the various obstacles to freedom that confront the research scientist. Although freedom is as essential to the scientist as the food he eats, Pierce concluded, it is not an end in itself, but must always be tempered with responsibility *(Science,* September 4, 1959).

Pierce left Bell Labs in 1971 and returned to Cal Tech as a professor of engineering. He is a former member of the President's Science Advisory Committee and a member of both the Committee on Library Research and Training Projects and the Science Advisory Committee of the American Newspaper Publishers Association. He is a Fellow of the Institute of Electrical and Electronics Engineers, the American Academy of Arts and

Sciences, the American Physical Society, and the Acoustical Society of America. In addition, he is a member of the National Academy of Sciences, the National Academy of Engineering, and the American Philosophical Society.

Pierce is the recipient of many awards. Seven colleges and universities, including Yale and Columbia, have awarded him honorary doctorate degrees. In 1979, Pierce was awarded the Guglielmo Marconi International Fellowship. He has received the John Scott Award in 1974. In 1964, he received both the HT Cedergren Medal of the Royal Institute of Technology, Stockholm, Sweden, and the Institute of Electrical and Electronics Engineers' Edison Medal. In 1963, Pierce was honored with the National Medal of Science and the Valdemar Poulsen Medal. He received the Stuart Ballantine Medal of the Franklin Institute in 1960, and in 1947 the Institute of Radio Engineers awarded him the Morris Liebmann Memorial Prize for his work in developing the traveling-wave tube. In 1942, Eta Kappa Nu named him the year's outstanding young electrical engineer.

Pierce's recreation consists mainly of reading and writing, though in the past he has also built and flown gliders. He is particularly interested in science fiction, which has influenced him throughout his career. In 1952 he suggested that science fiction writers replace their tired tricks and hackneyed plots with new findings in the sciences, including biology and anthropology.

On the occasion of Echo I's launch, Pierce expressed the opinion that it was not necessary to copy the Soviet Union in everything and that an independent course of action was frequently more fruitful.

u contributed by Diana L. Hollenbeck

Ports

Hardware components used to link computer systems and peripheral devices such as modems; monitors; printers; and hand-held pointing devices, such as a mouse. They provide the physical connection for the input and output of information by these devices with the computer system. They are also called I/O (input/output) ports.

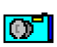
Ports are the physical gateways for communication between computers and input/output devices such as modems, printers, keyboards, and mice. They provide the means for data retrieval and input, as well as for linking computers together in networks.

There are two basic types of ports, each supporting the type of data transmission required by different peripheral devices. Serial ports allow two-way, bit-by-bit communications with serial devices, such as modems, mice, and optical character readers. Because they send and receive information one signal at a time, serial ports are slow. However, they also allow straight-forward information transfer between peripherals that are located far away from each other.

Devices that use parallel interfaces, such as printers, connect to computer systems through parallel ports. These ports are faster, allowing several bits of information to be transmitted simultaneously. However, peripherals using parallel ports must be located closer to a computer than peripherals using serial ports. Parallel ports are also only capable of sending information, unlike serial ports, which can both send and receive information.

Computer systems generally have several built-in I/O ports to accommodate both serial and parallel devices. How many ports and the type of ports a system needs are governed by the hardware the computer uses; that is, a computer used for various types of data transmission will need more serial ports than would one designed as a desktop publishing workstation.

u contributed by Sonia Weiss



Potter, Henry Sayre (1798 – 1884)

American financier who was an organizer and first President of the Western Union Telegraph Company.

Henry S. Potter was born at Galway, New York, on February 14, 1798, to Nathaniel Job and Mary Sayre Potter. His family emigrated from England in the seventeenth century. When Potter was 14 he became a clerk in the Pittsford, New York, store of Samuel Hildreth. Not long afterward, Potter became the manager of the store and of Mr. Hildreth's business. In 1832 he went into business for himself. His enterprise consisted of a store, warehouse, ashery, and distillery. Ten years later he abandoned the liquor branch of his business and became a staunch temperance advocate. He refused to rent any of his property to the liquor business and his block, at the corner of State and Andrew streets, in Rochester, New York, bore the lettering H.S. Potter's Temperance Buildings.

On September 13, 1824, he married Harriet Benedict. They had five children: Charles B., Mary E., Alfred B., Susan J., and Henryetta. In 1850, he settled in Rochester and devoted himself to extensive financial undertakings. He entered the lumber business of William Cook & Company with his two sons, Charles and Alfred.

In the spring of 1851, Potter and 12 other Rochester investors pledged $83,000 to Hiram Sibley's effort to construct a telegraph line between Buffalo, New York, and St. Louis, Missouri, via Cleveland and Cincinnati, Ohio, and Louisville, Kentucky. From the outset of this project, it was clear that the promoters wanted to establish a monopoly over the telegraph business along their chosen route. Their plan was to absorb existing lines rather than construct new ones.

On April 1, 1851, Potter was elected first President of the New York & Mississippi Valley Printing Telegraph Company. After numerous failures to consolidate other lines and faced with a continual shortage of money, by the end of 1853 the New York & Mississippi Valley Printing Telegraph Company found itself with only a single line of wire connecting the cities of Buffalo, Cleveland, Columbus, Dayton, Cincinnati, Frankfort, and Louisville. The company's original plans had been foiled. New subscriptions of stock were sporadic, while the old ones were partially paid or canceled entirely. Rival lines fiercely opposed consolidation and, faced with a lack of funds, the company struggled financially.

On February 21, 1854, the company reorganized. Within a week, some 25 Rochester men assembled in Hiram Sibley's office. Although most of those in attendance, Potter included, viewed their stock merely as one of many investments, Sibley was the driving force attempting to commit this group to the telegraph technology. He asked for $5,000 from each to consolidate lines in the West. That evening, $100,000 in financial support was garnered and the consolidation effort was renewed.

The strongest opposition the company faced was the consolidation of the Erie and Michigan Telegraph Company's 900-mile line from Buffalo to Milwaukee, a line controlled by Ezra Cornell, founder of Cornell University, and others. After much negotiation, the consolidation between the Erie and Michigan Telegraph Company and the New York & Mississippi Valley Printing Telegraph Company was agreed to. Cornell insisted that the name of the united company be The Western Union Telegraph Company, to indicate the union of the western lines into one system. This was the first item in the consolidation agreement of November 1, 1855. The formal consolidation came after the New York legislature passed an enabling act on April 4, 1856. Potter was an incorporator and served as President of the Western Union Telegraph Company until July 30 of that same year, when Hiram Sibley assumed the presidency.

Possessing formidable business acumen and financial strength, Potter was able to organize the effort to construct telegraph lines between Buffalo and St. Louis and connect with the West through consolidation of existing lines. With the original $100,000 and the lines obtained through consolidation, the property of the Western Union Telegraph Company soon exceeded in value the whole assessed value of the real and personal property of the city of Rochester.

u contributed by Diana L. Hollenbeck

PRIMESTAR Partners

American company that provides direct broadcast satellite (DBS) television to customers throughout the continental United States.

PRIMESTAR Partners, founded in 1990, offers DBS television service to consumers across the continental United States. Its founding partners include six major U.S. cable companies — Comcast Cable, Continental Cablevision, Cox Communications, Newhouse Broadcasting, Tele-Communications, Inc. (TCI) and Time Warner Cable — and GE American Communications.

PRIMESTAR subscribers are provided with a 36-inch satellite dish that receives programming from a GE American Communications' satellite. The programming is beamed to the satellite from transmission sites in Colorado and New Jersey. When the signal reaches the satellite, its power is increased. The signal is then relayed back to Earth and to the customer's reception dish. From the dish, the signal is channeled through the customer's in-home converter box before it reaches the customer's television set.

Over 70 channels of programming are currently provided to PRIMESTAR subscribers. The company plans to deploy two high-powered, state-of-the-art satellites in 1996, which will make up to 200 channels available. Programming choices include entertainment, sports, news and music. All major networks are offered, as well as movie channels, pay-per-view options and news programs.

In April 1994, PRIMESTAR became the first DBS service to offer digital video and audio to its customers. This technology significantly improves picture and sound quality over broadcast and cable television analog programming. Today, all PRIMESTAR signals are transmitted digitally.

Currently, PRIMESTAR is working in collaboration with its cable company partners to establish a national network of service centers. Staff members at these centers route calls received on PRIMESTAR's national toll-free telephone lines to regional PRIMESTAR offices. This approach increases PRIMESTAR's local presence for installation requests and customer service. In addition, PRIMESTAR has launched an advertising campaign in selected markets.

u contributed by Susan P. Sanders

Gray, James L. (1935 –)

American telecommunications industry executive; currently Chairman and Chief Executive Officer of PRIMESTAR Partners.

On November 1, 1935, James L. Gray was born in Canton, Ohio. Gray completed his undergraduate studies at Kent State University in Kent, Ohio. Later, he earned a master's degree in business administration (MBA) from the State University of New York in Buffalo.

Gray has more than 20 years experience in the cable, telecommunications and satellite industries. In 1974, he joined Warner Cable and advanced through a number of operating positions before being named President of Warner Cable in 1986. Following the 1992 merger of Time, Inc. and Warner Communications, Gray was appointed Vice Chairman of Time Warner Cable, based in Stamford, Connecticut. He served in this position until 1994.

Gray has served as a member of PRIMESTAR Partners' board since 1992 and became PRIMESTAR's Chairman and Chief Executive Officer in January, 1995. Gray joined John J. Cusick, PRIMESTAR's President since 1991, at the company's helm.

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In the January 30, 1995 issue of *Electronic Media*, Gray described PRIMESTAR's plans for the future, predicting, This is the year you'll be hearing a lot more about PRIMESTAR. We're going to ramp up our visibility through marketing and advertising and expansion of channels. Gray also noted the company planned a big expansion of our distribution network and would also increase our retail presence. Gray clearly intends to position PRIMESTAR as a major presence in the fast-growing DBS industry.

Gray served on the board of the National Cable Television Association from 1986 to 1992 and was a member of the board of the Turner Broadcasting System from 1987 to 1991. Previously, he was Chairman of the executive committee and a Director of C-SPAN. In addition, Gray has participated on the boards of E! Entertainment Television, Cable in the Classroom and the Walter Kaitz Foundation

u contributed by Susan P. Sanders

Printers

Printers are graphical devices that enable the material displayed on a computer screen to be transferred to paper.

Printers have long been one of the most important peripheral devices in a computer system. By interfacing with the computer's central processing unit (CPU), printers process binary information from the computer's memory, translating the information into words and images on paper.

Types of Printers
Most printers fall into two basic categories, offering prices to suit most budgets and features appropriate for different types of printed documents. At the low end of the scale for both price and print quality are character or impact printers, which create documents by striking a printing mechanism against an inked ribbon. The image is then transferred to the paper behind the ribbon to form characters and words.

Most character or impact printers in use today are dot matrix printers, which use small, pin-like hammers to form letters and graphics. Many print one character at a time; others print an entire line at a time by moving back and forth on the page. These printers, while versatile and inexpensive, do not deliver the high quality of other types of printers. They are most often used for printing such things as drafts of other materials, long reports, and multi-part forms. Due to their low cost, they are ideal for home computer users not requiring high quality document output.

Daisy wheel printers are another type of character or impact printer. These printers, which were among the first developed for use with personal computers, use an interchangeable wheel with long, thin spokes. Its shape resembles that of a flower, hence its name. Each of the wheel's spokes carries a raised letter. As the printer selects each character for printing, the wheel rotates to that letter, which is then struck by a small hammer against the ribbon and paper. Daisy wheel printers produce letter-quality documents, but they are slow and noisy, as well as limited to text-only documents. They are rarely found today.

Non-impact Printers
Non-impact, or page printers print entire characters or pages at a time using laser, ink-jet or thermal-transfer technology to form characters without physical contact between printing mechanisms and paper. Their technology uses fewer moving parts, making them faster and quieter than impact printers. However, their advanced technology makes them more expensive as well.

Laser printers are the most popular type of printer in use today, as well as being the most common non-impact printer. They deliver high-resolution text and graphic printouts quickly and quietly and are capable of producing a number of different typefaces in all sizes and styles. Most also come with multipurpose paper trays, allowing images to be transferred to various sizes of paper, envelopes, labels, transparencies, and other materials.

Laser printers use electrical charges created by lasers and light-sensitive drums to print documents. Instructions from the computer's CPU tell the printer to beam its laser across the light-sensitive drum. The laser beam is turned on and off, charging the surface of the drum in a pattern of dots that create images. The drum then rotates, and ink from a toner cartridge adheres to the charged areas. As the paper passes by the drum, the toner is attracted from the drum onto the paper. From there, heated rollers press the toner into the page as it passes through a fusing station.

Output quality differs among laser printers. Like computer display screens, the number of dots per inch determines how sharp and realistic the text and graphics will be. Less expensive printers produce documents at 300 dots per inch (dpi). For desktop publishing applications, a higher resolution print of at least 600 dpi is recommended, and 1,200 dpi is commonly available. Most laser printers only print in black and white; however, desktop color laser printers are now entering the marketplace.

Ink-jet printers, which create documents by spraying electrically charged ink droplets through tiny nozzles, are a popular alternative to laser printers. They are quieter than laser or impact printers, less expensive, and can produce high-quality output almost as sharp as many laser printers. Because each nozzle on an ink-jet printer can hold a different color of ink, they are also an affordable choice for printing four-color documents. Ink-jet technology is used on portable bubble-jet printers as well.

Solid-ink and thermal-transfer printers are other types of printers commonly used for four-color desktop printing. These printers, which are capable of producing high print quality, use heat to melt images from a wax-based ribbon directly onto specially treated paper. They produce clear, bright color graphics but cost significantly more than ink-jet and laser printers with color capacities.

u contributed by Sonia Weiss

Public Broadcasting Service (PBS)

A nonprofit television system whose 345 members are comprised of noncommercial, educational television stations. PBS is based in the Washington, D.C., suburb of Alexandria, Virginia.

Using television as an educational tool dates back to 1952, when the Federal Communications Commission (FCC) reserved television channel positions for the express purpose of broadcasting noncommercial or educational television. Funding for these stations initially came from various foundations and private grants. The Ford Foundation, which had been funding numerous educational television entities, established the Educational Television and Radio Center (ETRC) in 1952. The primary purpose of ETRC was to provide for an exchange of programming between educational TV stations. In May 1953 Houston's KUHT became the first educational television station. During the mid 1950's additional educational stations were launched by state or local governments or agencies, universities or colleges, or nonprofit community associations. Each group had a different objective and agenda, which caused a lack of focus in a potentially powerful group.

In 1959 ETRC changed its name to the National Educational Television and Radio Center. Four years later, it dropped the pretense of any radio affiliation and became simply National Educational Television (NET) and, with additional foundation funding, created a full-service production facility. At the time, television stations using NET programming weren't hooked up to a central broadcast feed like other networks. NET programs were mailed to a few select stations that promptly aired them and then mailed the tapes to the next station. This program delivery system was called bicycling.

By 1967 the future of educational television brightened and its fortunes turned around. The Ford Foundation paid interconnection costs between NET member stations and, for the first time, live programming was transmitted to its stations.

Also in 1967, the Carnegie Commission on Educational Television published a report titled *Public Television: A Program for Action.* The term educational television was out and public television (PTV) was in. PTV was specifically chosen to better represent the majority objective — that public television represent a wide range of educational and enrichment opportunities. The report focused on the different types of television: mainly broad-appeal, network television; instructional classroom television; and noncommercial public television. The report determined that the country needed a better, more effective public television system and the government would have to raise taxes to ensure PTV's funding and future. The Commission's many strong and (according to some observers) thoroughly-evaluated recommendations for PTV became the basis for The Public Broadcasting Act of 1967.

Specifically, the 1967 Act provided funding for additional stations, a nonprofit corporation to head and organize the stations, and a study of instructional television. Funding was to come from an annual congressional appropriation. Additionally the Act established the Corporation for Public Broadcasting (CPB), which encompassed radio as well as television. Its responsibilities were to oversee the distribution of funds as well as the interconnection of PTV stations. A new chapter in public broadcasting ensued.

To reach one of the 1967 Act objectives, that all PTV stations be interconnected, the CPB and American Telephone & Telegraph (AT&T) negotiated for land line connections. In 1969 the CPB set up the Public Broadcasting Service (PBS), which became the interconnection management service for PTV. The PTV stations were controlling members of PBS, which in turn, acted as the voice for the stations in all governmental, technical, legal and developmental areas to the CPB. PBS was, in effect, the literal physical link from the CPB to the public stations.

As PBS increased its programming transmission, it replaced NET's transmissions, although NET still produced or sold programming to PBS. The administrative, programming and technical interconnection that started with the Ford Foundation, and that continued under the auspices of PBS, made the loosely linked PTV stations a network of sorts. Unlike traditional television networks, PBS didn't produce any programming and it charged its member stations for program transmission. Furthermore, PBS was, and still is, owned by member stations. These distinctions differentiated PBS from a traditional television network like NBC. Lastly, while traditional network-affiliated television stations could pre-empt a network feed and air their own programming, few did so due to the expense and some compensation contracts. However, since PTV stations paid for programming, they were free to manipulate their schedules to accommodate viewers. From the beginning there have always been some PTV stations that take very little PBS programming.

The 1970's saw PBS's maturation. Diverse shows such as *Sesame Street* , Julia Child's *The French Chef; NOVA; Upstairs, Downstairs* and full coverage of the Watergate hearings gave PBS its personality for the decade. PBS was intellectual, well-intentioned, somewhat high-browed and even humorous, but always educational.

However the 1970's also ushered in a time of squabbling among the participants in noncommercial television. President Richard Nixon's administration frequently demanded decentralization and attacked the PBS network. PTV station owners were unhappy with NET's control over programming and CPB's control over funds. Congress addressed the issue of program content with threats of withholding funding. Finally PBS President Hartford Gunn eliminated the irksome problems and satisfied most parties by forming the Station Program Cooperative (SPC) in 1974, which used direct station input to produce and pay for programming. The Public Broadcasting Financing Act of 1975 provided for forward funding in which funds are appropriated for a specified number of years in the future and thus discouraged revenge cuts like those threatened by the Congress earlier in the decade.

In 1978, the stations that earlier had lagged behind with bicycling program delivery made a giant leap in technology when PBS became the first American broadcast television system to use a satellite to transmit to member stations. Within a year PBS reorganized, shed its governmental and advisory duties, and focused only on programming content and delivery to its member stations.

The 1990's have seen yet more changes in the structure of PBS. Member stations have given PBS more control over programming in terms of a stronger role in development.

The ever-increasing need for funding has escaped no one, including the 1995 Speaker of the House, Newt Gingrich, who in an effort to trim the federal budget, suggested the government not subsidize public broadcasting of any kind. Fifteen years earlier, the Reagan presidential administration first suggested the same thing. However, the government's role is not as large as some constituents may think. For example, for fiscal year 1993 the federal government supplied just over 20 percent of public television funding. The remaining nearly 80 percent came from subscribers, businesses, foundations, etc. Additionally, the CPB states that 90 percent of the government funding goes directly to communities for programming, which, in theory, should make a station and its programming more responsive to local viewers.

A hallmark of any noncommercial broadcast entity has been the underwriting of programming, that is, providing money to the station or network in exchange for the company, organization or individual's name mentioned on the air. Traditionally underwriting messages are limited to a statement such as Funding for this program is provided by XYZ. Over the years, the FCC and Congress have eased the underwriting rules so that some underwriting messages look remarkably like commercials. Many public station owners are reluctant to sell the underwriting ads because they fear public perception will change and funding will be even harder to come by. Yet, as the 1995 House Appropriation Committee has voted to cut the CPB budget by 15 percent for 1996 and 30 percent for 1997 and eliminate it altogether by 1998, many stations will have to make up the deficit or cut back on air-time.

When PBS found its niche in the 1970's, by definition and content, its look was drastically different from the commercial networks and stations. During the cable boom in the 1980's, however, the delineation between public and commercial TV blurred. A handful of cable networksfound success in programming similar to PBS without the noncommercial restraints and government funding issue. So, due to cable competition and possible funding cuts, PBS may have to reorganize and alter its personality again.

PBS not only has a place on the dial, but also a loyal audience to support it. In a study conducted in October 1994, almost 80 percent of Americans watched public television, with the average home watching for eight hours that month.

A leader in television technology, PBS's activities include a wide variety of educational and programming services for numerous consumer groups. As PBS moves into the next century, its history and its challenges place it in a very interesting spot.

u contributed by Michele Messenger

Public Switched Telephone Network (PSTN)

Historically, public switched telephone network (PSTN) referred to the U.S. public telephone system, including the telephones, local lines, switching equipment, and the complete system of trunks and services that make up the network. Today, the definition remains basically the same, but the companies that provide these services have changed drastically. In addition, the phrase *public switched telephone network* is now used to refer to the worldwide voice telephone network. In this article, it will be defined only as it appears in the United States.

The PSTN can be divided into two general sections: the "local exchange networks," which provide local transmission service, and the "interexchange networks," which provide long-distance transmission services.

The Local Exchange Networks
Local exchange telephone companies (LEC's) provide service within certain geographic areas known as Local Access and Transport Areas (LATAs). The LECs are regulated by state public utility commissions (PUCs). The best known of the local telephone companies are the seven regional Bell operating companies: Ameritech, Bell Atlantic, Bell South, NYNEX, Pacific Telesis, SBC Communications, Inc. (formerly Southwestern Bell Corporation), and US West. But there are also several independent companies, such as GTE, that provide local service. Within its LATA, each LEC provides a number of regulated services that can be divided into two basic categories: exchange services and exchange access services.

Exchange services consist of local telephone services, from simple dial tone and custom calling to Centrex. Exchange access services connect the local exchange networks to the interexchange networks, allowing local telephone customers to connect to long-distance carriers.

The Interexchange Networks
The interexchange portion of the network is composed of long-distance or interexchange carriers (IXCs). IXCs offer a variety of long-distance services, including various options for voice and data transmission. These can include items such as 800 and 900 numbers and Wide Area Telecommunications Services (WATS). Although AT&T, MCI, and Sprint are the best known of these companies, there are over 500 long-distance companies currently in operation. Some are huge and have their own networks. Others simply buy long-distance time from other companies and resell it to customers.

Although the PSTN is a huge, complex network, it used to be a fairly simple concept: one telephone company serving all of the telephone needs of the United States. Since AT&T's divestitureand the breakup of the Bell System, these telephone needs are being served by a growing number of individual companies competing for local and long-distance business and offering a myriad of services and rates.

u contributed by Linda Stranahan

Radio Frequency Spectrum

The portion of the electromagnetic spectrum that is used for all radio communication and television channels. The radio frequency (RF) spectrum ranges from 3 kilohertz to 300 gigahertz.

RF Spectrum
Electromagnetic waves, which travel at the speed of light (186,000 miles per second, or 299,000 kilometers per second), are defined by their *frequency, length* and *amplitude*. Frequency is the number of waves that pass a given point in one second. The length of a wave is one complete cycle; from the peak of the wave, down to its lowest point, then back up to the peak. Lengths of long waves are measured in thousands of miles, while short waves are measured in millionths of millimeters. Amplitude is the magnitude, or strength, of the wave, which is related to the power (expressed in watts): for example, an AM radio station that broadcasts with 50,000 watts.

The first person to measure the length of electromagnetic waves was Heinrich Hertz, a German professor whose experiments in the late 1800's proved that electromagnetic waves could be used for wireless communication. The term *hertz* is used to refer to the frequency of these waves. One thousand waves per second is one kilohertz (kHz), one million waves per second is one megahertz (MHz), and one billion waves per second is one gigahertz (GHz).

The total RF spectrum ranges from 3kHz to 300GHz. Within it, RF signals are classified into eight frequency groupings: very low frequencies (VLF), 9 to 30 kHz; low frequencies (LF), 30 to 300 kHz; medium frequencies (MF), 300 to 3,000 kHz; high frequencies (HF), 3 to 30 MHz; very high frequencies (VHF), 30 to 300 MHz; ultra high frequencies (UHF), 300 to 3,000 MHz; super high frequencies (SHF), 3 to 30 GHz; and extremely high frequencies (EHF), 30 to 300 GHz.

Within the RF spectrum, frequencies are designated for 28 types of radio communication services. These frequencies are established for exclusive government use, exclusive non-government (public) use, and shared use by government and non-government entities. In addition, some frequencies are assigned to primary, secondary and permissible users, with the provision that the signal of the primary user takes precedence over the other two and cannot be interfered with by those sharing its use.

Every radio station and television channel is assigned a specific frequency for its broadcasts. This prevents adjacent signals from interfering with each other, a situation that could cause a problem for essential communications, such as air traffic control, maritime communications, and police and fire communications. The cable television (CATV) industry is allowed to use frequencies that have been assigned for other purposes because a CATV system is closed and the signal never leaves the cable or CATV equipment. Strict rules and fines apply to the CATV industry if cable signal leakage, called egress, exceeds prescribed limits.

Broadcasting

The VHF and UHF frequencies are divided into sections called *bands,* which are used for broadcast television signals. The width of the band (bandwidth) determines how much picture and sound information can be transmitted. The channels assigned to these frequencies can be received by antennas that are installed on an individual's home or attached to a television. The SHF frequencies are also divided into bands, which are set aside for different types of communications. One band of frequencies within SHF is used for multichannel multipoint distribution services (MMDS); another for television station remote transmission to a studio via microwaves or satellites; a third band is for CATV transportation systems to carry signals to their headend as well as other applications; and the Ku band, from 12 to 14 GHz, is used for very small aperture terminal (VSAT) networks, terrestrial microwave, and the distribution of programs by national television networks. The Ku band is also used for direct broadcast satellite (DBS) services that use satellites and small dish antennas to distribute signals directly to a home receiver.

When a television signal is transmitted, the electrical signals from the camera and microphone modulate, or change, specific parts of an RF signal called a carrier wave. The frequency of the carrier wave defines the channel and carries the information that defines the picture and sound. In a color television signal, there are three distinct carriers for the video, audio and color information. The information about each element is used by the transmitter to modulate part of the RF signal. The receiver demodulates the signal by removing the RF signal, leaving the video, audio and color information, which is then used to generate a color picture with sound.

Although standards vary in different countries, North America uses a standard called NTSC, which was established in 1953 by the National Television Standards Committee. In NTSC, a television channel is 6 MHz wide. Within the 6 MHz bandwidth is all the video, color and audio information. Video signals are in a single sideband, with the picture carrier located 1.25 MHz above the lower frequency boundary. The video signal has a bandwidth of 4.2 MHz. Within the video band, the color subcarrier is 3.58 MHz above the picture carrier. The audio carrier is on the other side of the bandwidth, .25 MHz below the upper boundary. Each channel is separated from those on either side by a guard band that prevents cross talk or interference between channels.

In the United States, four bands of frequencies are used for television broadcasting:
1) 54 to 74.6 MHz;
2) 75.4 to 88 MHz;
3) 174 to 216 Mhz; and
4) 470 to 806 MHz.
These bands are divided into 68 television channels.

Broadcast radio frequencies are designated as either amplitude modulated (AM) or frequency modulated (FM). An AM radio signal uses changes in the amplitude of the RF signal to transmit sound. An FM radio signal uses changes in the frequency of the RF signal to transmit sound.

Medium-frequency AM broadcasting is allocated the frequencies from 535 to 1,705 kHz. High-frequency AM radio uses the frequencies from 2,300 to 26,100 kHz. High-frequency AM radio is used for international broadcasting and long distance mobile communications with ships and aircraft. Commercial FM broadcasting is done in the frequency range from 88 MHz to 108 MHz.

Allocation of RF Spectrum
Since 1927, the federal government has assigned frequencies for various types of communications that use RF signals. Government intervention in RF signal usage was necessary during the "radio wars" of the 1920's, when radio broadcast stations deliberately interfered with the signals of competitor stations. Today, the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA) are charged with allocating licenses for frequencies and ensuring that technical standards are met. The FCC is responsible for managing the public uses of the RF spectrum for the public convenience, interest and necessity. The NTIA manages spectrum use by government agencies. Both agencies, in conjunction with the U.S. State Department, participate in international conferences on RF spectrum management.

In 1953, the FCC allocated 12 channels for the broadcast of VHF television, 54 MHz to 216 MHz, and 70 channels for UHF television, from 470 MHz to 806 MHz. At the time, television was a new phenomena, one that many critics said was a fad that wouldn't last, and 12 VHF channels seemed ample for an industry that started with four networks. In some large cities with multiple local affiliates and some independent stations, the VHF dial filled up and UHF channels were used for local broadcasts.

Periodically the FCC and NTIA review frequency allocations and increase or decrease the bandwidth that is committed to a particular service based on many factors. Among them are: separation between frequencies to control interference, amount of bandwidth that is required for the service, capability of the transmitter to put out a specific frequency without drifting from it, sensitivity of the receivers and the power of the transmitter, and the size of the geographic area that is served.

Prior to 1994, the FCC either gave licenses away or held lotteries that granted the "winner" a license to use a commercial frequency free of charge. The recipient could use the frequency or sell the license to a company or individual who could use it to provide a communication service. As communication technology has changed, new types of services have become possible, but since the RF spectrum is a finite resource, signals that carry data, voice and messaging services have become very valuable.

Expanded uses for the RF spectrum have made radio frequency licenses a commodity that is subject to the economic factors of supply and demand and the RF spectrum a valuable resource that can generate billions of dollars in revenue for the owner of a license. For example, in 1993, Motorola sold licenses for 2,500 radio frequencies to Nextel Communications for $1.8 billion. The FCC conducted RF spectrum auctions in 1994 and 1995 that generated over $7.7 billion. Reflecting the changing face of electronic communications and the convergence of the telephone, broadcast television, cable television and computer industries, the licenses were bought by a variety of companies.

The FCC auctions were the first to open frequency licensing to bids. The FCC started auctioning licenses for thousands of frequencies to be used for interactive video and data services (IVDS), voice messaging, paging, personal communications services (PCS), and a new type of digital service called personal digital assistants (PDAs). The PCS industry will enable customers to use pocket phones, and PDAs allow users to send and receive digital information with computers and fax machines, wireless video, E-mail, and voice messages to pagers and other pocket phones — anywhere in the world.

While the FCC regulates all uses of public RF signals, it does not require all users of frequencies to have a license. For example, microwave ovens, cordless telephones, baby monitors, walkie-talkies and garage door openers all use radio frequencies. Since these devices are very low power, only effective within a small area, and cause little interference, their use is unrestricted by the FCC.

New advancements in technology include transmitters that can monitor all frequencies and automatically change the broadcast frequencies to ones that are not being used, and spread spectrum, a transmission method that spreads a signal out over several frequencies and reassembles the message at the receiving end.

Although much is known about the electromagnetic spectrum and radio waves, they still have their mysteries. For example, several studies have raised the question of whether the electromagnetic waves used to carry cellular phone signals can cause health problems for users.

In the late 1800's when Guglielmo Marconi proposed using radio frequencies to broadcast messages, the idea was dismissed because this type of message could be received by anyone who had a receiver tuned to that frequency. That "problem" eventually became the basis of all commercial radio and television broadcasting, but for people using radio frequencies for private communications, the problem of privacy is very real. Sending a message using an RF signal, whether it's a direct link between two devices or from a transmitter to a satellite or a tall tower, means that anyone with a receiver tuned to that RF signal can listen in on the communication. The lack of privacy, especially when the communication involves critical information, is a genuine concern for all users of wireless services.

u contributed by Paul Stranahan

Radio Satellite Broadcasting

The unending advance of communication technology has had a profound effect on radio broadcasting. In fact, advances in broadcast radio technology have often broken ground for other communication industries. Radio satellite broadcasting has helped revitalize the broadcast radio industry and the growth of a wide variety of national radio networks. The inherent economies and efficiencies of satellite broadcasting, in turn, have helped radio stations around the country offer a wider array of services and program selection.

Radio Satellite Broadcasting — Pie in the Sky That Works
When broadcast television broke into the American scene in the late 1940's — begging, borrowing or downright stealing anything that wasn't tied down in the broadcast radio industry, including popular programs, famous personalities and most profits — the broadcast radio industry appeared to be doomed. A little known music phenomenon, rock and roll, and a few visionary radio programmers and disc jockeys led the way to radio's recovery.

By offering narrowly defined program formats, such as top 40, golden oldies, classic or easy listening, radio stations could target specific audiences for their advertisers. Realizing what a good thing this was, the radio industry began churning out a whole slew of different formats during the 1950's and the 1960's.

But, given their limited scope and resources, few individual stations had the wherewithal to provide their listeners with comprehensive news coverage. This proved to be the saving grace for the national radio networks that were savaged by television's ascendance. The American Broadcast Company (ABC) radio network led the way in 1968 by tailoring its news and feature coverage to the four most popular radio formats. This proved so successful that the network soon expanded the number of different news services to seven. While it took NBC and CBS almost two decades to catch up, they too eventually began offering tailor-made news coverage for their affiliate stations.

But, the advances in radio satellite broadcasting in the 1970's were what really changed the landscape of radio network broadcasting. Satellite technology, which during the 1960's space race had been almost futuristic and other worldly, was finally put to work in the 1970's. Advances in launch technologies and procedures, and eventually the development of reusable launch vehicles like the space shuttle, have made satellites fairly mundane today.

As satellites became more commonplace, they also became infinitely more affordable for communication industries to use. As a result, radio broadcasters have been able to provide national service, whether it's formatted music programs or tailor-made newscasts on the hour, with little or no interference and with a great deal of economy. In fact, satellite broadcasting became so popular (and commonplace) in the radio broadcast industry that by 1990 nearly 20 national radio networks were competing for affiliates throughout the country.

Most, if not all, of the bigger music networks provide a wide variety of different formats.

These formats can range from several variations of rock, to a few country formats, to an easy listening format and possibly a classical format. Some of the formats are so finely tuned that they vary according to the seasons; for example, spring/summer selections are more upbeat, while fall/winter music is more laid-back and romantic.

Some of the more well-known satellite music networks include: Westwood One (which owns Mutual Broadcasting and the former NBC radio network stations), ABC/Satellite Music Network, and Jones Satellite Networks (offering more than a half-dozen specific formats including FM Lite, Good Time Oldies, Z Spanish — a Spanish-language music format, and The Team — an all-sports format, among others.

Radio Satellites Spread the Word, Music and News

The advantages of radio satellite broadcasting over other ground-based relay systems are significant. While other systems are inherently limited in their reach (from one point to the next and so on in a chain-link fashion), satellites are able to reach an unlimited number of receiving stations in a given area. In addition, unlike ground-based transmission systems, an increase in the number of receiving stations in a satellite system does not increase the cost of transmission.

Distance is another factor that has little impact on satellite transmissions or relays. The reach of radio relays and transmissions on the ground can be severely limited or attenuated (restricted) by landscape and atmospheric conditions. Additionally, the quality of ground-based signals can also suffer if they have to be repeatedly reamplified as they are relayed around the country. Satellite transmissions, on the other hand, amplify signals just once before they are sent down to receiving stations on Earth.

Radio satellites operate in geostationary orbits approximately 22,000 miles above the equator. The counteracting forces of nature on this unique position allow objects like satellites to essentially keep pace with the earth's rotation, thereby appearing to be stationary over a specific area of the earth's surface. This phenomenon occurs because the centrifugal force that would normally toss the satellite out into deep space is counterbalanced by the gravitational force that draws it back to Earth.

Generally, a single satellite has a line-of-sight coverage of 40 percent of the earth's surface. A satellite's coverage area is called its footprint. The size of a satellite's footprint can be altered by the shape of the beam produced by its transmitting antennas. A global beam, used for continental coverage, spreads over the satellite's line-of-sight. Regional coverage is accomplished by hemispheric beams that cover approximately 20 percent of the earth's surface. Because they're narrower, spot beams, which cover 10 percent of the surface, also possess higher power when received on Earth.

Satellites, like ground-based radio transmitters, are also controlled by international agreements. Communication satellites operate on International Telecommunication Union (ITU) designated channels. Satellite transmissions are restricted to microwave frequencies between 3 and 15 GHz (gigahertz: billion cycles per second). Satellites, depending on their function, utilize specific bands within this frequency range.

Most communication satellites, including those used for radio broadcasting , operate in the C band, or 3 to 6 GHz frequency range. The Ku band, or 11 to 15 GHz band, is used primarily for direct broadcast satellite (DBS) television systems. While earthbound microwave services operating in the C band can sometimes interfere with C-band satellite transmissions, Ku-band signals are not affected.

Radio broadcast satellites themselves have five basic components. *Transponders* are electronic units that receive, amplify and then transmit signals back to Earth. Antennas both receive signals from Earth (uplink) and transmit signals back to Earth (downlink). Uplink and downlink signals consist of both programs and telemetering information on the satellite's condition and position.

The *power units* on a broadcast satellite consist of storage batteries and an array of solar cells. In fact, power units and fuel used for adjusting a satellite's position with thrusters account for most of a satellite's weight. Fuel limits, in turn, dictate the operational life of a satellite. Currently, most satellites have an average 10-year operational span. Other key satellite elements include the *thrusters* themselves and the various *telemetering devices* that monitor satellite operations.

Most C-band satellites carry 24 transponders. Each transponder can carry numerous narrowband radio signals. This allows these satellites to simultaneously receive and transmit a wide variety of radio signals and network services.

Satellite Broadcasting Broadens Traditional Boundaries

No longer restricted by earthbound transmission systems, radio broadcasting has found an economical, largely interference-free transmission system among the stars overhead. This increasingly efficient satellite relay system has helped increase the number of national radio networks now serving the United States.

Like the individual stations they serve, the networks are themselves purposefully targeted, offering specialized services and niche programming. As the number of satellites increases, and as more sophisticated equipment is utilized by radio stations around the nation, the fully automated radio station becomes more common. As a result, the distinctions between local, regional and national stations diminish and the sense of community expands. Once again, radio broadcasting takes the lead.

u contributed by Michael C. Lafferty

Radio Corporation of America (RCA)

An American manufacturing, entertainment and broadcasting company that began as a government-sanctioned monopoly in 1926 for the purpose of sending and receiving international and maritime radio signals.

Radio Corporation of America (RCA) was created by an agreement between General Electric (GE) and the U.S. Navy to provide a “controller” of all the patents issued to further the radio broadcast system in the United States. And while RCA’s purpose was to send and receive radio signals, as patent problems arose and technology was developed, RCA’s responsibilities changed.

In 1895, decades before RCA was established, Guglielmo Marconi developed a system that more effectively transmitted electrical waves. Instead of transmitting electrical impulses through wire, his system sent these waves through the atmosphere. Marconi of America, controlled by British Marconi, had exclusive rights to this invention. But that didn’t prevent companies and individuals from tinkering with Marconi’s invention in an effort to refine it. While broadcast capabilities would eventually be explored, most tinkerers were thinking about telephone applications for the invention.

After the turn of the century, another inventor, Lee de Forest, developed the Audion, or triode, vacuum-tube, which amplified the voice. De Forest sold his rights to American Telephone & Telegraph (AT&T) in the early 1900’s. De Forest based his invention on another invention — Sir Ambrose Fleming’s two-probe tube — to which American Marconi had the rights. Both AT&T and Marconi believed they had legal rights to proceed in the radio *receiving* business, yet more problems regarding patents were about to arise.

The inventions and tools necessary to run an effective radio *broadcast* system were in place by 1917. The problem was that there were too many players. Simply put, too many different companies had the rights to too many small pieces of the puzzle.

World War I then both stopped and furthered radio progress. During the war, the government suspended all patent rights, which effectively stopped the tinkering. However, the government took all of the elements of radio transmitting and receiving and utilized them to form a workable radio system for the war effort. When the war was over, the patent rights went back to their original holders and the so-called industry was back at the beginning.

One of the companies holding patent rights was GE. GE owned the Alexanderson alternator, which transmitted radio waves. In 1919 the only potential customer for the alternator was Great Britain. The U.S. Navy did not want the British to gain access to and total control of radio broadcasting, which they would have with the purchase of the alternator. So GE, which acquired the Marconi Company of America, and the U.S. Navy came to the agreement that resulted in the founding of RCA. At about the same time, a young manager of the Marconi station at Sea Gate, New York, was thinking about the possibility that radio might well develop into a private, non-government communications tool. His name was David Sarnoff , and he would become RCA's visionary leader in the coming decades.

But patent problems were not over. There were still too many companies involved. Finally the Westinghouse Electric and Manufacturing Company, AT&T and GE all agreed to utilize RCA to manufacture a radio receiver and then to divide up the various part production responsibilities. From 1919 to 1921, the details of agreement for the radio partners were developed. GE and Westinghouse manufactured radio sets. RCA bought the sets — 60% from GE, and 40% from Westinghouse. RCA then sold the sets.

AT&T always believed that the transmission of the voice was its "property," and the company's role in the agreement was to manufacture, sell and lease transmitters. All three independent companies, Westinghouse, GE and AT&T, had stock interest in RCA as well as up to four seats on the RCA board of directors.

All the pieces were in place; all the players knew the rules. Radio was primarily a military, government and maritime tool. No one had addressed the *business* of broadcasting. Yet between 1920 and 1922, all of the partners, including RCA, were operating and experimenting with their own radio stations. One of the experiments concerned how to make money with radio stations. In August 1922, AT&T's New York station, WEAF, sold ten minutes of air time for $50 to Queensboro Corporation to help "sell" its new Hawthorne Court residential area. Many were appalled that radio was used in such a transparent way to raise funds. However, within three weeks, WEAF had air-time revenues of $27,000. By the following January, the station had 13 sponsors and radio had become a consumer business.

In the early 1920's, there simply wasn't enough programming to support all of the stations that were broadcasting. AT&T started interconnecting its stations by AT&T long lines. Networked stations and a much larger audience per broadcast were the result. AT&T did not want to produce programs; it was only interested in transmission. In 1923 and 1924, AT&T connected more and more radio stations. It should be noted that AT&T's network, or chain of stations, was experimental only, and since it did not originate programming, it did not fit today's definition of network. RCA and Westinghouse tried to set up their own networks but AT&T refused to lease its long lines. Networking, while not prohibited, was hampered.

In 1925 AT&T sold its RCA stock and was no longer represented on the board. The company intended to manufacture receivers when RCA-controlled patents expired. The two former partners, RCA and AT&T, entered into arbitration. RCA won, and during the negotiations RCA's David Sarnoff suggested that the National Broadcasting Company (NBC) be formed from the radio stations owned by all of the partners. In July 1926, AT&T agreed to sell its stations to RCA in return for RCA's commitment to use AT&T long lines for future interconnection. In effect, RCA, GE and Westinghouse all had their original responsibilities plus the radio station group when the new NBC network went on the air officially in November 1926. The new radio station group was split in ownership, with RCA owning 50%, GE 30%, and Westinghouse 20%. Additionally, there were enough radio stations to form two networks. NBC operated the then new Red Network as well as its sibling, the new Blue Network.

In the 1920's David Sarnoff rose through the ranks at RCA from the engineering side to the management side and then clear to the top of RCA in 1929. Although he experienced more power at RCA, he stayed very involved with NBC. While a lot of credit would be given to Sarnoff for his expansion, attention to inventions and development and general style, a number of his decisions had unfortunate outcomes for the company. Sarnoff was excellent at entering new fields with very little cost. However, he frequently raised cash by licensing many RCA inventions and patents, which left the company without a market share or niche. Yet while eroding future growth opportunities, the selling of licenses did allow for both radio and later television to grow through competitors' efforts.

In May 1930, RCA bought both GE's and Westinghouse's interests in NBC and then consolidated the two companies' manufacturing facilities within RCA. Two years later, the government forced GE and Westinghouse to divest their RCA stock while allowing RCA to continue manufacturing. So by 1932, RCA wholly owned NBC and was an independent business.

RCA was becoming very powerful. It manufactured and sold radio sets, owned a radio network, supplied marine communications, and expanded into motion pictures and theaters, artist management, recording services and phonograph manufacturing and sales. Under RCA's parentage and the leadership of David Sarnoff, who was voted in as President in October 1929, NBC flourished. A few months after the network's debut, another network that was soon known as Columbia Broadcasting System, or CBS, was NBC's only competition. Indeed within ten years, RCA, which had started as a government-sanctioned wireless monopoly, grew into a major player in broadcast and entertainment. For most of the 1930's and a great deal of the future decades, NBC would be RCA's main, and sometimes only, profit center.

In the late 1930's NBC and CBS played an important role in the development of the new medium, television. Most importantly, the networks embraced it. RCA, which stood to sell millions of receivers, also pushed for television broadcasting. Again a war halted progress. During World War II, RCA focused on wartime efforts and the parent company brought in three times the revenues that NBC did. But when the war was over, the rush for television was on with RCA pushing hard.

By the spring of 1944, NBC was broadcasting television shows four nights a week. Sarnoff had created an atmosphere in which invention and engineering were rewarded, and the company was a leader in technology. In 1947, at the NBC radio affiliates meeting, Sarnoff urged the radio station owners to apply for TV station licenses. By 1948 there were four television networks: NBC, CBS, DuMont and the American Broadcasting Company (ABC), and all were televising shows to their affiliates. But, as with radio, RCA didn't dominate the television manufacturing field as it could have because so many licensing rights were sold to competitors. One move RCA made to combat smaller market share, however, was to set up a vigorous repair system. In a short time, the company was known for excellent service after the sale.

As early as 1948, CBS began exploring color television as the public became increasingly aware of this new entertainment possibility. But Sarnoff was also interested, and he was prepared to battle CBS for rights and superiority. The Federal Communications Commission (FCC) decided in 1949 that CBS's color system was superior to RCA's and gave the go-ahead for color broadcasting to start in 1950. In response, RCA's Sarnoff took a number of strategic steps: he ordered his research department to keep working on its system while at the same time he looked into purchasing licenses from CBS. Also, in a bold defensive move, he organized a group of black-and-white TV set producers who promised not to produce color sets. This organization was called the National Television Systems Committee (NTSC). ABC and DuMont even agreed to stall any plans to switch to color. For these two networks, switching was a moot point. Neither had sufficient advertising or programming support to provide the great amounts of cash flow necessary to make the switch to all-color broadcasting. In fact, in a few years DuMont would cease to broadcast and when ABC was forced to move to all-color programming more than 20 years later, it was very, very costly.

CBS's color system did have problems, and since the Korean War had piqued interest from viewers, there was a surge in black-and-white television set sales. But finally color television was brought to the masses by Congress. In March 1953, a House Committee investigated the hold-up of color broadcasting and looked into an alternative color broadcasting system promoted by RCA. In its research, the committee found the new system superior to CBS's and deemed it ready. On December 17, 1953, the FCC surprisingly agreed and reversed its earlier decision. NBC was ready to go with color productions for the Christmas viewing season. Equipment manufacturer Admiral, with help from RCA's licenses, had color television sets selling for $1,175 in stores by December 30. By March 1954, NBC had at least ten shows produced in color every week. CBS, which actually agreed that the new system was superior, also started to make the move to color. ABC and DuMont had to stall for still more time and money.

During this time, some of RCA's business strategies were setting the foundation for problems that would develop over the next 30 years. RCA continued to sell licenses, a practice which bolstered competitor's products and ate away at its potential industry dominance. The company also decided to expand into other household appliances, such as air conditioners, refrigerators, ranges, washing machines, etc. Most of this expansion was once again made with little capital investment. RCA then made the unwise decision to go up against International Business Machines (IBM) and produce data processing equipment, which drained capital and resources while producing minimal revenues.

By the late 1950's, NBC was again bringing in almost all of RCA's profits, but the overall profit margin was dropping. In the early 1960's, however, with color television firmly in place, RCA's bottom line looked healthier. The company had purchased Hertz Rental Cars, Random House, Arnold Palmer Enterprises and other businesses in a variety of industries. In 1965, Sarnoff announced he would leave his post as RCA's CEO, but retain the Chairmanship. Illness eventually forced him out completely in 1969. In the meantime, Sarnoff's oldest son, Robert, moved up from President of NBC to President of RCA.

Robert Sarnoff, as RCA's CEO, sold off the marine radio operations and other divisions. The RCA logo was redesigned and the motto and slogan were changed. The company structure was also altered, and Sarnoff stated publicly that RCA would no longer give away market share.

In 1971, RCA sold the electronic data processing division, now called the computer systems division. NBC had lost some luster, but was still producing strong revenues for parent RCA. However, the rest of the company was not so healthy; so RCA concentrated on the remaining business lines as well as some newer technologies, such as video recorder systems. As the entire country's business climate was changing, RCA sold some divisions and acquired some others.

By 1975, RCA's share of color televisions sold annually dropped to an all-time low of 19%, and in the fall of that year Robert Sarnoff was out. Again, RCA restructured and under new CEO Anthony Conrad, RCA again showed promise. However, he lasted less than a year, and yet another new CEO was elected, Edgar Griffiths. Under him, RCA did less spectacularly but survived. The economy turned around in the late 1970's, which made RCA look stronger in a better light. RCA was still licensing patents it controlled, and a full quarter of its income was coming from such endeavors.

In the late 1970's, NBC started to feel the pangs of too much belt-tightening, weak programming and some questionable decisions. It became apparent to management that Griffiths was not the right man to run the company. In 1981 Thorton Bradshaw was named as RCA's fourth CEO in six years. Bradshaw was the senior outside director on RCA's board. He had come from Atlantic Richfield and was totally different from all of the previous CEOs, including David Sarnoff. Almost immediately Bradshaw started worrying about a hostile takeover. So Bradshaw, on the offensive, started looking at possible new owners for RCA. In 1986 RCA was sold to GE — the very same GE that, together with the U.S. Navy 60 years prior, set up RCA to prevent British domination of the communications industry. RCA sold for $6.3 billion dollars, a huge amount that set a record for the then largest American non-oil business transaction.

Today, RCA has ceased to exist as a company, but the brand name of RCA is still used for some communications products. David Sarnoff would have been proud of the 1986 selling price of his wireless communications company.

u contributed by Michele Messenger

Randolph, Sandford F. (1913 –   )

American businessman and cable television pioneer. Randolph was the first manager of the Clarksburg (West Virginia) Cable TV Company. He was also President and part owner of Cablevision of Virginia, Inc., which served Covington and Clifton Forge, Virginia. Randolph is now retired.

The Salem, West Virginia, native accomplished a lot before he joined the U.S. Navy Reserve during World War II as a Lieutenant in the Armed Guard Service. He started his professional life by selling refrigerators door-to-door in Clarksburg. In 1934 he moved to Washington, D.C., and worked for the U.S. Department of Agriculture and the Treasury Department. While in the capital, he clerked in a department store and acted as a tour guide on various sightseeing buses. In 1939 Randolph moved back to Clarksburg and launched and operated the Randolph Insurance Company through the war and until 1953. From 1950 to 1952, he sold prefabricated housing units, building 120 National Homes in just three years.

In 1953 the franchise for the Clarksburg cable TV system had been awarded to two companies — J.H. Whitney and Company, and Fox Wells TV Cable, Inc. Randolph joined the new cable system in Clarksburg as its manager even before construction was started on the company headquarters. This new cable system went through a number of owners, and Randolph managed the system for all of them. He gained notoriety in the cable business when, in 1959, United Artists Theaters sued the Clarksburg system and its then-owners, the Fortnightly Corp., for copyright infringement. United Artists claimed that Clarksburg originated some programming and was therefore in violation of simple transmission rules that the new cable companies all over the country were to adhere to. The suit lasted nine years and was eventually heard by the U.S. Supreme Court. Clarksburg won, thanks in no small part to Randolph. He was credited with coolly handling the intense pressure and scrutiny during the lawsuit.

Randolph continued his cable career as the President and co-owner of The Cablevision of Virginia system. The owners sold the company in 1968 to Jerrold Electronics Corporation.

Randolph, a strong believer in the cable TV business, has also been active in the industry's trade organization, the National Cable Television Association (NCTA). He was elected to the Board in 1954, the Vice Presidency in 1959, the Presidency in 1960, and he was the first national Chairman. He is committed to preserving important aspects of the past, and he has been very active in the NCTA Cable TV Pioneers. Throughout the 1980's and into the 1990's, Randolph has handled all of the Cable TV Pioneer day-to-day duties. Randolph's extra time is devoted to the Board of Directors of the National Cable Television Center and Museum. In 1995, Randolph was the first recipient of the Sanford Randolph Golden Coat Award presented by the NCTA Cable TV Pioneers. The award is given to pioneers in the cable industry who have performed unusual or extraordinary services.

The cable industry grew with tenaciousness during the 1950's and 1960's. A large measure of tenacity came from Sandford Randolph and his fellow pioneers. They were astute businessmen who broke the trail for today's information superhighway.

u contributed by Michele Messenger

Sarnoff, David (1891-1971)

Russian-born American communications and broadcasting executive, primarily known for his pioneering contributions to radio and television.

Sarnoff was born in Russia in 1891, and his family immigrated to New York City when he was nine years old. He began working for the Marconi Wireless Telegraph Company in 1906, first in the office and then as a telegrapher. Legend has it that Sarnoff was the first telegraph operator to pick up the *S.S. Titanic*'s distress signal as it was sinking in 1912, although this has recently been disputed. With typical foresight, Sarnoff proposed the idea of a commercially marketed radio receiver to Marconi management in 1915, but it was ignored.

When the Radio Corporation of America (RCA) absorbed the Marconi Company in 1919, Sarnoff stayed on as Commercial Manager. Seven years later, he organized the National Broadcasting Company (NBC) as an RCA subsidiary and the first permanent radio broadcasting network. Its purpose was to provide programming that would help sell more RCA radios. The network's first program included four hours of entertainment featuring humorist Will Rogers and several dance bands, broadcast live from the Waldorf-Astoria Hotel.

At the New York World's Fair in 1939, Sarnoff presented RCA's new television system to the public when he televised President Franklin Roosevelt's address to open the Fair. And in the 1940's, he established the NBC television network to help sell RCA TV's, at times serving as the network's President.

From 1930 to 1947, Sarnoff held the presidency of RCA. He served as Chairman of the Board until 1970 and Honorary Chairman of the Board until his death. Under his leadership, RCA became a leader in the manufacture of radios, televisions, electronic parts and equipment, and broadcast production and transmission equipment.

While running RCA, Sarnoff also served as General Dwight D. Eisenhower's chief of communications during World War II. In 1944, he was promoted to the rank of brigadier general.

David Sarnoff died in 1971 at the age of 80, one of the foremost figures in the history of broadcasting.

u contributed by Kay S. Volkema

Satellite Dish (or Earth Station Antenna)

A type of antenna designed to send and receive satellite signals.

Satellite dishes are powerful antennas that transmit and receive radio waves to and from satellites orbiting the earth. Also referred to as earth station antennas, these devices are able to pick up extremely weak radio signals that have traveled thousands of miles through space and back to Earth.

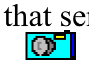
At one time, satellite dishes were only owned by government and commercial interests. But in 1979, the Federal Communication Commission (FCC), which regulates radio communication in the United States, made them much easier to own and operate. Today, the impact of that decision and subsequent rulings affecting the satellite industry are still being felt in the United States. In 1994, direct broadcast satellite (DBS) companies began to compete with cable television by beaming television programming via satellite to 18-inch satellite dishes owned by DBS subscribers.

Of course, satellite dishes are used for more than just television broadcasting and reception. Dishes come in a variety of shapes and sizes and have a range of uses including tracking satellites, radar, and data transfer.

How Satellite Dishes Work

Though there are many sizes and shapes of satellite dishes, the one most familiar is the prime-focus parabolic (bowl-shaped) antenna. As radio waves that have been transmitted from a satellite strike the surface of the antenna, they are reflected to a feedhorn located above the center of the dish. The feedhorn collects the reflected signals and guides them to the electronic component (or components) which amplify the signals and lower their frequency. Other parabolic antennas include the cassegrain and offset. Used mainly for commercial purposes, cassegrain antennas use a sub-reflecting lens in front of the feedhorn. The offset antenna is a parabolic antenna with the feedhorn equipment not centered directly over the dish.

Just as a radio or television antenna receives signals within a certain frequency range, so does a satellite dish. The signals a satellite dish receives, however, are much higher than radio or television signals. Radio frequency is measured in hertz, or the number of wave cycles per second. AM radio signals are measured in kilohertz (kHz), or thousands of wave cycles per second; FM radio and television signals represent millions of cycles per second and are rated in megahertz (MHz). The signals that satellites pick up are measured in gigahertz (GHz), or billions of wave cycles per second.

The satellite dish that sends a signal to a satellite is called an uplink earth station antenna (or satellite dish)  . The uplink earth station sends radio waves to the satellite in a tightly focused beam. Because this beam is so narrow, the uplink antenna must be pointed in the direction of the satellite. After the satellite receives the uplink signal, it changes the signal's frequency and sends it back to Earth. Satellite dishes that receive signals relayed from satellites in this manner are called downlink earth station antennas (or downlink satellite dishes). They too must face the direction of the satellite.

Some satellite dishes, however, are designed to capture signals from more than one satellite. They may do this simultaneously by using multiple feed horns located in front of the dish. Other satellite dishes focus on one satellite at a time. Some systems' motorized mount moves the dish in the direction of the desired satellite.

With communication satellites, satellite dishes transmit and receive frequencies that fall within two distinct bands (or frequency ranges). The C-band uses signals between 5.925 and 6.425 GHz for uplinking and 3.7 and 4.2 GHz for downlinking. After the signals are directed through the feed horn, they are then lowered even further by an antenna's downconverter.

C-band satellites are low-powered satellites, which means the signals that they send back to Earth are very weak. By using low-power downlinks, the signals sent to Earth from satellites will not interfere with ground-based, point-to-point microwave systems that operate within the same frequency range.

By contrast, Ku-band satellites use frequency ranges between 14.0 and 14.5 GHz for uplinking and 12.2 and 12.7 GHz for downlinking. The Ku-band satellites provide stronger downlink signals. DBS uses a high-frequency portion of the Ku-band and uplinks at 17.3 to 17.8 GHz and downlinks 12. 2 to 12.7. The signals the DBS systems send back to Earth are high-powered.

The strength of these signals directly affects the size of the satellite dish. That is because the fainter the signal, the more signals the dish needs to collect in order to produce a usable signal. With a larger surface area, a dish can collect more signals. C-band dishes tend to be 8 to 10 feet in diameter. Ku-band tend to be about 3 to 6 feet in diameter while DBS satellites have a diameter of 18 inches.

Dish Performance
There are several ways to measure the performance of a satellite dish. Two of the most important include measuring an antenna's gain (power amplification) and the amount of noise (interfering signals) that an antenna is able to screen out. Antennas with a high gain-to-noise ratio achieve better reception than those with low ratios.

Gain
Gain refers to the amount of signals that a dish can capture and then concentrate into beam and send to the feedhorn. Bigger dishes are designed to provide greater gain. Also, high frequency waves provide greater gain because they are easier to concentrate into a narrow beam and deliver to the feedhorn. The shape of a dish is another factor that impacts the gain an antenna has. Just as a microscope with a lens that has been crafted imprecisely will produce a fuzzy image, a dish that does not have an accurate shape will have poor gain.

Noise
The electromagnetic radiation that satellite dishes are designed to pick up comes from many sources other than the satellites beaming signals. These sources include land-based microwave systems, fluorescent lights, and energy naturally produced by the Earth itself. By keeping the angle at which the antenna is directed at a higher elevation, this type of signal interference can be reduced. Another type of noise, called thermal noise, relates to

the temperature of the electronic component (called a low-noise amplifier, or LNA) that amplifies signals collected by the feedhorn. The warmer the LNA becomes, the more thermal noise is generated.

Noise and gain are only two ways that engineers look at a dish's performance. Other criteria include beamwidth (the dish's range of sight), and the ratio of focal length to dish diameter (f/D ratio). The f/D is determined by the depth of the dish.

Applications
After the 1979 FCC decision that made it easier for individuals to own and operate satellite dishes, television receive only antennas (TVROs) began cropping up in backyards all over the United States. These backyard dishes were popular among people who live in rural or so geographically rugged areas that they could not obtain cable television. By 1986, however, many satellite broadcasters began to scramble their signals so that only those viewers who leased a satellite descrambler could receive their television signals.

Because of regulatory changes and advances in digital technology, home satellite dishes once again made a resurgence in 1994. The new DBS dishes were much smaller and less expensive than earlier backyard dishes which were anywhere from 6 to 10 feet in diameter.

By the late 1980's, all major broadcasting networks had begun distributing programming to their local affiliates using satellite uplinks. The local affiliate station broadcasts the network feed via conventional antennas to the local viewing audience. Also, mobile uplinks (dishes mounted on trucks) have enabled news organizations to provide live, on-the-spot coverage from virtually anywhere in the world.

Business organizations have also harnessed advances in satellite dish technology. Using very small aperture terminals (VSATs) businesses are able to operate private networks for video conferencing, data transfer between individual sites, and for such specific tasks as delivering background music to department stores. Today there are approximately 60,000 VSATs in use in the United States.

Satellite master antenna television (SMATV) systems are used to distribute television programming to an entire building or campus. For instance, a hotel or motel may use the a SMATV system to provide non-broadcast television channels to its guests.

It is likely that as new applications for satellites are found and advances in satellite and earth station technologies are made, satellite antennas will become an increasingly important part of our communication systems.

u contributed by Christopher LaMorte

Satellite & Wireless Trends

New applications for wireless technology stretch around the world and into outer space. Fast and efficient communications, even to remote areas, are becoming widespread as wireless technology precludes the need for extensive wired infrastructures. Viewers watch programming delivered wirelessly by direct broadcast satellite, teachers use video conferencing to instruct students hundreds of miles away, and personal digital assistants (PDAs) update telecommuters with messages, faxes, and database feeds.

As wireless communications facilitate information exchange within the global community, they also enhance the potential for universal access to information. While many find these developments beneficial, others perceive the flow of data across borders as a threat to their culture's integrity and their country's sovereignty.

Within the business arena, companies find themselves allying with age-old rivals. The extraordinary cost of implementing ambitious projects, such as global satellite systems, demands cooperative efforts.

The wireless network market in the United States alone is expected to grow tenfold by the year 2000. Companies, countries and consumers alike will feel its growing pains but also will derive its benefits. The following are some of the major trends in wireless technologies.

Direct Broadcast Satellite (DBS)

Direct Broadcast Satellite (DBS), acclaimed for its laser disc-quality images and CD-quality sound, transmits programming via satellite directly to subscribers' television sets. Gone is the need for underground cabling or a huge satellite dish.

Digital compression technology, which significantly increases the number of channels each satellite transponder can handle, has become a driving force in DBS service. When PrimeStar Partners, a major DBS system provider, switched from analog to digital technology in mid-1994, its number of channels nearly doubled to 77.

Each DBS provider expects to continue increasing its number of channels. For example, the transponders on GM Hughes Electronics' two DBS satellites, which transmit DIRECTV's and USSB's programs over Digital Satellite Service (DSS) systems, eventually will be able to transmit up to ten channels each, doubling their initial transmission capability. This equates to 320 DSS channels at full capacity. Similarly, PrimeStar promises to offer 150 channels by 1996.

Along with more channels, DBS will generate more competitors. EchoStar Communications intends to become a major player, eventually providing 250 channels after it launches its first satellite in late 1995. And cable companies are taking measures to compete against DBS head-on. Sophisticated fiber-optic technology currently under development will eventually deliver hundreds of channels. In 1996, Tele-Communications Inc. (TCI) — the largest multiple system operator (MSO) in the United States — plans to launch two high-power satellites that will deliver digital programming to its cable systems.

Competition will keep the primary DBS players, DSS and PrimeStar, tweaking and fine-tuning their products. Both are converting to a new data compression standard called MPEG-2, a successor to the Motion Picture Expert Group (MPEG) standard, which DSS initially used. This new standard is expected to overcome problems that occur when a picture changes rapidly, specifically the problems that result in random on-screen blocks of color and momentary freezes.

Regarding programming, DBS viewers can anticipate many features now available on DSS or PrimeStar to become standards. Among them are a programmable favorite channel list, automatic shut-off timer, alternate audio button to switch between languages on bilingual stations, pay-per-view spending limit, movie rating limit, and channel lockouts. Sports programming options, such as DSS's NFL season ticket (with which viewers can select among 12 games not airing in their area) will increase. Opera fans, classic car collectors and other special viewer groups will find channels that match their interests when USSB introduces its superstation with Mini-Mass programming.

Since data ports already exist on DBS receivers, providers may also offer data services to subscribers. Among likely selections are weather information, stock quotes, ticket ordering, home shopping, video games and travel services.

If consumer enthusiasm for DBS continues at the pace demonstrated with DSS's 1994 rollout — nearly 500,000 subscribers signed up within the first six months — DBS systems may eventually become as popular as cable television in American households.

Global Satellite Systems

As early as 1998, three global satellite systems will begin providing wireless voice and data service internationally through handheld telephones. The process started in 1992, when the World Administrative Radio Conference (WARC) designated a slice of the electromagnetic spectrum for use worldwide by the global satellite system competitors. In January 1994, the Federal Communications Commission (FCC) issued licenses to three bidders: Loral/Qualcomm for its Globalstar system, Motorola Satellite Communications for its Iridium system, and TRW for its Odyssey system. Now the three bidding parties must obtain agreements with telephone companies as well as licenses in every country in which they want to operate. Interfacing with and switching among nations' communication standards will be eased by digital signal processing (DSP) technology.

Although the competitors' satellite networks differ, all place non-geostationary satellites in circular orbits and use dualmode handsets that operate as satellite phones only when they cannot make a cellular link. TRW's Odyssey system features medium earth orbit satellites (MEO) that operate at an altitude of 5,600 miles. In contrast, Iridium and Globalstar use low earth orbit satellites (LEO) operating at altitudes of 420 miles and 750 miles respectively. The Iridium design calls for 66 satellites, compared to Globalstar's 48 and Odyssey's 12. Likewise, costs vary. The estimated cost for construction, launch, and operation for one year ranges from $1.5 billion to $3.7 billion.

Launching these projects into the heavens requires worldwide participation and cooperation among government entities, scores of telephone companies, and consortiums of technological corporations.

Initially, the cost of a global satellite phone call will deter most consumers. Price-per-minute estimates start at Globalstar's $.30 plus ground long-distance charges and soar to Iridium's $3 with ground charges included. Handsets also run the gamut, from Odyssey's $550 to Iridium's $3,000. Over the long term, however, the combination of technological advancements and competition should drive costs and prices down.

Personal Digital Assistants (PDAs)

The first generation of small, handheld computers known as personal digital assistants (PDAs) hit the marketplace in the late 1980's, only to frustrate users with quality and functional problems. Foremost among the problems was PDA's key feature, recognition of handwritten input. Because few people write in a manner accurately recognizable by recognition software, input error rates were disastrous. Other limitations included short battery life, inadequate hard drive space for downloaded files and faxes and difficulty in connecting with electronic services .

The PDA market potential, though, has encouraged companies to focus development efforts on overcoming the product's limitations. Some manufacturers have dropped handwriting recognition altogether. Instead, their PDAs come equipped with onscreen keyboards that users operate by tapping with a stylus. This significantly increases accuracy and makes it easier for users to correct mistakes . Although most PDAs come equipped with one or two megabytes of memory, the capacity will most likely increase to four or more megabytes within the next few years. Increased hard drive capacity and improved battery life now free PDA PCMCIA slots for their intended purpose of connection to outside networks and electronic services. Prior to these improvements, users often needed to use the PCMCIA slots to connect to extra battery packs, keyboards and other external devices.

Manufacturers are also creating software packages geared specifically to PDAs. With these products, users will be able to organize messages, take notes, balance their bank accounts, send faxes and connect with their offices. They will also be able to call home and carry important personal data, such as credit card numbers and health records.

Microsoft, Intuit and other software companies are developing specialized on-line services that will enable PDA users to track stock market quotes, make credit card purchases, and track on-line expenses. In addition, on-line services and Internet providers are teaming up with PDA manufacturers to encourage PDA users to receive and transmit electronic mail (E-mail) messages. For example, Motorola and America Online (AOL) recently announced a plan whereby AOL members can receive their E-mail messages free of charge by using any one of Motorola's PDA products. A new type of software called an *agent* makes it easier for PDA and other users to access an array of on-line services. In essence, the agent dials up a service, requests the user-specified information and performs filtering and other preliminary tasks for the user.

Provided that this next generation of PDAs succeeds in overcoming earlier limitations, analysts expect the consumer market for PDAs to build gradually over six to eight years, with shipments spiking later in the decade, when prices should decrease from a $700 to $1,000 range to around $300.

Transborder Data Flow

Advancements in information technology and services have heightened concerns over transborder data flow. Nations first demonstrated their concerns in the 1970's, when multinational enterprises began marketing computer systems within their borders. To prevent dependence on foreign sources for data processing equipment and services, many countries, such as Brazil, implemented national information policies that imposed strict regulations on international data communication links, imports of computer products and foreign ownership of firms.

The enhanced wireless transmission capabilities of the 1990's have intensified some nations' wariness about transborder data flow. With widespread dissemination of video programming via satellites and global information interchange among private citizens via the Internet, information flow expands beyond commercial entities to include the populace at large.

Of particular concern is the impact of transborder data flow on national information sovereignty and security, domestic economic development, privacy protection and cultural integrity. Recognizing that information is power, many countries are addressing these concerns with national privacy and data protection laws. Iran, for example, now prohibits citizens from owning satellite dishes in order to prevent receipt of foreign programming — and its assumed infringement on Iran's cultural values.

Protectionism, however, conflicts with the global thrust of information technology: development of fast, efficient and convenient communication from any point to any other point. Wireless technologies, such as cellular telephones and satellite transmissions, have made efficient communication possible in remote areas and developing countries, where the cost of creating wired infrastructures had been prohibitive. If industry predictions hold true, by the turn of the century, people will be able to talk with other individuals and access databases worldwide via wireless personal communication networks (PCNs) interlinked by global satellite systems. Voice and data communications will readily transcend borders wirelessly. As a result, efforts to control the flow and content of information will become increasingly difficult.

Video Conferencing

Using cameras, satellites and telephone lines, video conferencing enables geographically-distant associates to meet. The addition of computers as components of video conferencing systems has made it possible to move many video meetings out of large, specially-equipped rooms and onto desktops.

Applications continue to grow, touching a broader range of society. In addition to the traditional meetings conducted by executives, for example, engineers located at different sites can now interactively develop product design. Instead of commuting to a classroom for video instruction by a remotely-located teacher, students now can attend class at home via their personal computers. Medical consultations by doctors practicing hundreds of miles away and interactive video job interviews may become commonplace . As by-the-hour prices for video conferences decrease, such as those jointly offered by Kinko's and Sprint (starting at $300 per hour for a two-way meeting), distant family members may even choose this medium to participate in 50th wedding anniversaries and other momentous celebrations.

Technologically, efforts are underway for standardization and compatibility among systems and networks. Key among them is a standard that will allow group meeting users on multi-point video conferencing (H.320 standard) to communicate with PC-based video conferencers. Another is expanded availability of Integrated Services Digital Network (ISDN) services, presently offered only in specific areas nationwide. If Multi-Rate ISDN and asynchronous transfer mode (ATM) services take hold, transmission costs will become less expensive. Eventually, teleconferencers may be able to connect using their choice of communication networks and protocols.

Many features will become standard on a number of systems and will become more sophisticated, too. Among them are full duplexing, which allows users to speak and hear another party at the same time; an increase in the number of multi-point locations; real-time document manipulation; use of different electronic ink colors for document annotation; touch-sensitive screens for presentation station controls; cross-platform operation between Macintosh and Windows-based operating systems; and improvement in video quality approaching that of television.

As these technological advancements evolve, desktop video conferencing may well become widespread.

The Expanding Roles of Wireless Providers

Until recent years, the type of service offered, such as cellular telephone or packet radio services, categorized wireless providers. Companies tended to participate in only one type of service. The advent of personal communication services (PCSs) and other technological advances, however, has integrated many wireless applications and product features. As a result, many providers now offer several categories of wireless services.

In addition, the costs of acquiring FCC licenses for PCS frequencies and of implementing PCS networks have spurred mergers, alliances and consortiums that integrate wireless providers' markets, resources, services and technologies. For example, Sprint Corporation and Bell Canada Ltd. have stepped beyond their traditional turfs to become major shareholders in the global wireless satellite system called Iridium. Likewise, BellSouth has joined a German consortium, E-Plus Mobilfunk, to provide PCS service in Berlin, Germany.

Besides entering via merger, new players have been individually entering service categories historically dominated by only a couple of providers. For instance, Nextel Communications Inc. joined key players Ram Mobile Data, Inc. and Ardis Company as a packet radio and specialized mobile radio (SMR) provider. After buying the licenses for dispatch service, Nextel then obtained government approval to use those frequencies for mobile phone service. As a result, the company now also provides digital cellular phone service.

Through its purchase of McCaw Cellular Communications, Inc., AT&T also managed to gain a foothold in the cellular phone market. The FCC's approval of this purchase diffuses the restrictions of the court-ordered divestiture in 1984 that barred AT&T from re-entering the local telephone market. Essentially, the acquisition of McCaw's cellular network makes it possible for AT&T to bypass local telephone companies' connection charges and provide long-distance services directly to its customers.

Likewise, the regional Bell operating companies (RBOCs or Baby Bells) want to reach beyond their local regions. Seeing active involvement in PCS networks as an opportunity to do so, several have joined alliances to be able to bid in the FCC auction. The consortium of Bell Atlantic, NYNEX, US West, Inc., and AirTouch Communications, Inc., (Pacific Telesis Group's wireless business spin-off) acquired a PCS license for 11 markets with its $1.11 billion bid at the FCC auction. With that move, four Baby Bells will soon be PCS providers.

In sum, the list of providers for wireless services, from paging and packet radio to spread spectrum and global satellite, dynamically grows and changes as new products and applications enter the marketplace.

u contributed by Nancy Muenker, with Leigh Ann Shevchik

Schneider, Gene W. (1926 –   )

American cable television pioneer, engineer, visionary, entrepreneur, and cable television company executive. Gene Schneider is best known as founder, Chairman and Chief Executive Officer of United Cable Television Corporation, a major U.S. television operator up until 1989 and founder and Chairman of United International Holdings, Inc., a leading provider of multichannel television services outside the United States.

Gene W. Schneider was born on September 8, 1926, in Enid, Oklahoma. From 1944 to 1946, he was an aviation radar electronics technician with the U. S. Navy. In 1949, he received a BS in Engineering from the University of Texas at Austin. In the early 1950's, Mr. Schneider began his cable television career when he, along with his brother, Richard, Bill Daniels, and four other cable visionaries, constructed one of the earliest CATV systems in the country, in Casper, Wyoming.   This was the founding of what later became United Cable Television Corporation.

In 1968, United Cable Television Corporation was merged with Livingston Oil (LVO Corporation). In 1974, LVO Corporation merged with Utah International and, prior to the merger, United Cable Television Corporation was spun off as a dividend to the stockholders of LVO Corporation. Shortly thereafter, in the fall of 1974, Schneider formed a group of investors which subsequently became the principal individual owners and directors of United Cable Television Corporation. Mr. Schneider had several executive positions with United Cable Television Corporation, including President, Chief Executive Office and Chairman of the Board.

United Cable Television Corporation merged with United Artists Communications in May 1989. The new company became United Artists Entertainment Company, and Schneider was named Chairman of the Board. In December 1991, United Artists Entertainment (UAE) was merged into Tele-Communications Inc. (TCI) based in Englewood, Colorado.

Schneider is the current Chairman and Chief Executive Officer of United International Holdings, Inc. Subsequent to the merger of United Cable Television Corporation with United Artists Communications, Mr. Schneider and several former United Cable executives and board members formed United International Holdings, Inc. (UIH). UIH was formed to pursue their multichannel television services and related business outside of the United States. UIH initially acquired UAE's cable operations in Sweden, Norway and Israel and certain other assets. UIH recently formed a 50/50 joint venture with an affiliate of Philips Electronics, N.V. of Eindhoven, the Netherlands. Mr. Schneider is Chairman of the Supervisory Board of this new entity, United and Philips Communications (UPC). UPC now has approximately 2.2 million subscribers and is the largest independant cable operator in Europe.

United International Holdings, Inc. became a public company on July 22, 1993, and is now traded on the NASDAQ exchange.

Schneider is a Charter Member of Cable TV Pioneers, has been a member of the National

Cable Television Association's (NCTA) Board of Directors, and served on a number of its committees. In addition, he is a founder of the Rocky Mountain Cable Television Association and is a board member for several other companies. He was a member of Tau Beta Phi Honorary Engineering Society.

A long-time resident of Denver, Schneider married Louise Rouillier Price on June 21, 1977. Together, they have six grown children.

u contributed by Valerie Switzer

Sculley, John C. (1939 –)

American business executive, primarily known for his successful leadership of Pepsi-Cola USA and Apple Computer, Inc.

Sculley was born in 1939 in New York City and was educated first at a day school for boys and then a prep school, where he was class president for six years in a row. As a youth, he was interested in electronic gadgets and ham radio operation, and excelled in both academics and sports. After graduation, he attended Brown University during the day and Rhode Island School of Design during the evenings. He received a BA in architectural design from Brown in 1961.

While attending Brown, he married his first wife, Ruth Kendall (who was stepdaughter to later PepsiCo Chairman, Donald M. Kendall) and they had two children.

Sculley went on to graduate school at the University of Pennsylvania's School of Architecture. But after developing an interest in marketing, he switched to the university's Wharton School, where he received his MBA in 1963.

He began his business career at McCann-Erickson advertising agency as a trainee Account Executive working on a research project regarding Coca-Cola. During this time, he and Ruth were divorced. Sculley then went to Pepsi in 1967 as a trainee, starting from the bottom and working his way up from bottle washer to market research to new product development. In 1970, he became Pepsi's youngest-ever Vice President of Marketing at age 31.

Three years later he was promoted to head up the company's international foods division, and in 1977, Sculley was named President and CEO of Pepsi-Cola USA, a division of PepsiCo. After a second marriage that lasted only briefly, he married his third wife, Carol Lee "Leezy" Adams, in 1978.

Steve Jobs, co-founder and Chairman of Apple Computer, Inc., first began pursuing Sculley through a "headhunter" in 1982 to officially run the company. Then the two began to meet personally to continue negotiations. And in 1983, Sculley left Pepsi and succeeded Armas "Mike" Markkula as President and Chief Executive Officer of Apple, which had just gone public the year before and was phenomenally successful in the burgeoning personal computing market.

But the mid-1980's were turbulent for Apple Computer, and co-founders Steve Jobs and Steve Wozniak left for different reasons. Yet over the next few years, the newly restructured company's net income increased along with its product line under Sculley's distinctive leadership, and he was named Chairman in 1986. He relinquished the role of CEO to Apple President Michael Spindler in 1993 while retaining that of Chairman, although he has since left the company altogether.

John Sculley will probably always be remembered as the man who helped Pepsi win the "Cola Wars" and who also successfully led Apple Computer through the difficult 1980's to become a major player in today's information marketplace.

u contributed by Kay S. Volkema

Computer Security/Privacy

The ability to keep private information held in a computer's memory. This data can include files, credit reports, tax information, and medical histories. In the recent past, many computer networks have been broken into, allowing highly secured data to be accessed by criminals. For a variety of reasons, including network protocols and human involvement, many computer analysts fear that true security will never be possible.

Individuals have been trying to break into secured computer files and networks since their debut. The reasons for these break-ins vary greatly depending on the persons involved. Many want access for the sheer pleasure of getting into an area that is considered secure. Others have a more diabolical purpose: they're interested in credit card numbers, financial data, and other hidden information that could be used to their personal advantage.

But problems with computer security can come from unexpected sources. A security breach often comes down to a matter of office politics. For example, an employer might want to look at an employee's E-mail to make sure he or she isn't conducting any personal business on company time. Another common situation is that an employee might want access to personal business data on a co-worker's desktop. In both of these cases, the snooper wouldn't necessarily consider the act an invasion of privacy but perhaps a necessary part of the working environment.

Unfortunately, computer security remains problematic for most law enforcement agencies. Laws regulating computer theft and invasion of privacy are vague at best. Some view any intrusion into secure files and data a crime. Others stipulate that a file must be damaged or copied before anything illegal has occurred. Even if a law has definitely been broken, police are at a disadvantage in catching the thief. They rarely have the computer expertise to track the criminal properly or access to up-to-date equipment that would give them the advantage. It's an unfortunate reality that computer criminals have easy access to society's most private information.

Take for example the case of Kevin Mitnick. Mitnick had a long history of breaking into secured networks. His exploits in cracking the security at American Telephone & Telegraph (AT&T) and MCI were written about in the book *Computer Hackers*. But in February 1995, he was arrested for his worst criminal activities yet.

For several months, the FBI and criminal investigators in the San Francisco Bay Area had suspected Mitnick of breaking into two of the nation's largest Internet providers, Netcom and WELL. Some files he gained access to contained over 12,000 credit card numbers of network subscribers. Mitnick had also broken into several other networks, including AT&T, CompuServe, and Pacific Bell. Along with cracking the networks, he targeted several journalists and computer security officials that he considered braggarts. Mitnick rerouted their telephone calls, read their E-mail, and generally made their lives miserable.

In the end he was tracked down by one of the computer security programmers he had targeted. With the programmer's help, the FBI traced Mitnick's scrambled calls into the networks from San Francisco, to Denver, and finally to Charlotte, North Carolina, where he was arrested. While there is no proof he used the credit card numbers or any other information that he obtained, Mitnick will be tried for several cases of embezzlement and probably will be in prison for quite some time.

While Mitnick is today's most famous computer thief, he is but one of thousands looking for ways to break into the world's computer networks. Computer criminals each have their own ideas on how to take the information and what to do with it. But no matter how a thief operates, the tools for cyber-crime are a simple computer, modem, and telephone line.

A new breed of computer thieves is using computer networks, such as the Internet, to commit crimes formerly committed on the street. Unlike Mitnick and many long-time network crackers who did it for the fun of breaking into a secure system, these new thieves' main goal is profit. For example, one variation of an age-old pyramid scheme, in which a writer sends a chain letter requesting money to be sent to names on a list, has found new life on the Internet, where it is hard to track down the identity of users. Piracy software rings, in which criminals exchange copyrighted computer programs, can be found on the major on-line services. New users are often talked into giving up their credit card and Social Security numbers to people posing as customer service representatives of the network. This type of behavior will continue to increase as the number of commercial transactions taking place on the Internet and other on-line services rises.

Outright theft is only one problem facing computer security. Computer viruses, programs designed to damage any software or hardware they come across, are appearing at an alarming rate. A similar type of program, known as a Trojan Horse, attacks specific types of files, such as financial data or customer databases. This type of destructive program can easily run amok in a company that has failed to properly back up its data.

As if these intruders were not enough, the government is also interested in taking a look at users' files. A recently introduced bill would have permitted the IRS to audit tax returns by looking at the spending habits of consumers. If there was any contradiction, the IRS would have been able to update the user's tax return to indicate the difference. Luckily, the bill was overturned due to public outcry. If it had passed, the IRS would have had access to everyone's credit card and banking transactions. But the government has not given up yet. A future possibility is the creation of a federally issued smart card that would carry an individual's personal and financial history. The card could track a person's use of credit cards, health insurance, and checking accounts. Law enforcement agencies like the idea because they could track parents who failed to pay child support, tax evaders, or even individuals who failed to pay parking tickets.

While there are advantages to this system, no one can guarantee its integrity. If put in the wrong hands, it could give health insurance companies, creditors, and employers an easy way to discriminate against potential applicants.

Many consumers are unaware of just how much information companies have on their spending and buying habits. The truth is, corporations can easily purchase lists that detail personal data that many assume is confidential. Companies conduct targeted mailings based on this practice, which is known as database marketing. When companies solicit buyers in the future, they may have access to such personal information as telephone number, address, income bracket, mortgage payment, children's ages, and previous purchasing habits.

There are many ways that computer users can increase their privacy and protect their equipment from computer viruses. The simplest ways are not to sign onto any computer networks, including the Internet and on-line services, or share floppy disks with others. Most computer crimes occur over a network where there are many users. In these situations, it is often difficult to track thieves down because they may be signing on using an assumed name or another's account. With respect to computer viruses, when users share disks, they might not know where the floppy has been previously. Even new program disks can carry a risk of infection, since computer viruses have been unknowingly spread directly from manufacturer to consumer via a floppy.

In the last several years, programs that recognize common computer viruses have come on the market. Unfortunately, new computer viruses come out more frequently than detection software. While programmers update software frequently, it may not be often enough to protect important files.

Another way to protect files is by using a password or encryption package. Most software programs allow users to assign a password before opening files. Encryption will encode files based on a mathematical algorithm. Users sending encrypted packages can agree on a key, similar to a password, that when entered will decrypt the files. While most encryption packages are hard to break, users may also lose or forget the key, leaving the document in unreadable form.

Companies protecting large quantities of secured data are coming up with more involved security measures. Some use two separate computers, one connected to a public network and one for internal use only. Other companies also use a number of independent programs to stall intruders, that are similar to building a firewall that protects the company computers from outside penetration.

On a publicly accessible network, computer security analysts recommend that owners or system administrators regularly check the network for corrupt files. They may also want to control who accesses their network by verbally verifying the authenticity of its users.

But the most important security measure a user can take is to back up data on a regular basis. If data is lost or corrupted, the user can reload the data and start again. Without back-ups, lost data will be hard to regain. The chances are that networks will never be completely secure, but the dangers can be contained.

u contributed by JDC Editorial Staff

Selden, Judge Samuel Lee (1800 – 1876)

American jurist, financier and a co–founder of Western Union Telegraph Company. Judge Samuel L. Selden supported and invested in expansion of telegraph companies that used the printing telegraph for message transmission. The company that he co-founded to operate in areas west of Buffalo, New York, evolved into the Western Union Telegraph Company, of which he was also a co-founder.

Samuel L. Selden was born October 12, 1800, in Lyme, Connecticut. In 1825, he began practicing law in Rochester, New York. He was a justice of the peace, first judge of common pleas in Monroe County from 1831 to 1833, and clerk of the eighth chancery circuit for several years. Justice of the supreme court of New York from 1847 to 1855 and judge of the court of appeals from 1855 to 1862, he received his LL.D. from the University of Rochester in 1856. Judge Selden retired to private life in 1862.

During his judicial career, Selden participated in the burgeoning telegraph industry. He provided financial assistance to Royal E. House to perfect his printing telegraph invention. By using this instrument, telegraph companies were able to lay line and operate without having to purchase rights to use the Morse code system. In late 1846, Selden, Hugh Downing, and Henry O'Reilly bought the right to use House's patent on the Atlantic and Ohio telegraph line.

In 1847, Selden and five other investors formed the Atlantic, Lake & Mississippi Telegraph Company to support entrepreneur Henry O'Reilly's endeavors to build telegraph lines from Philadelphia to Pittsburgh, Pennsylvania, and Wheeling, West Virginia.

Later in that year, he and Hugh Downing entered into another agreement with Royal E. House. This one geographically divided rights to House's printing telegraph patent. Downing's rights covered the Atlantic seaboard and New England; Selden's rights included the state of New York and an option for the rest of the United States, which he exercised later.

Selden and his associates organized the New York State Printing Telegraph Company, which linked New York and Buffalo, in 1849. In order to construct a telegraph line from Buffalo, New York, to St. Louis, Missouri, Selden turned to business leaders of the progressive, rapidly growing city of Rochester, New York, for financial assistance.

A plethora of telegraph companies, duplication of service, and distrust, however, had created chaotic industry conditions that made it difficult for the company to secure necessary funds to carry out its project. Hiram Sibley agreed to invest in the company only under the condition that its primary goal be acquisition of all telegraph interests west of Buffalo. When Selden and his partners agreed, they won both a major stockholder and an outstanding promoter. As a result, a consortium of several businessmen organized the New York & Mississippi Valley Printing Telegraph Company on April 1, 1851, and adopted the guiding principle of consolidation through purchase of existing lines instead of construction of new lines.

The New York & Mississippi Valley Printing Telegraph Company reincorporated in 1856 as the Western Union Telegraph Company. Selden, a co-founder, sat on its board of directors. Hiram Sibley was elected its president. By 1860, the company's lines reached from the eastern seaboard to the Mississippi River and from the Great Lakes to the Ohio River. In 1864, it purchased the nation's first transcontinental telegraph line, whose construction it had orchestrated. With acquisition of the United States Telegraph Company and the American Telegraph Company in 1866, Western Union Telegraph Company emerged as a national monopoly.

Judge Selden married Susan Ward of Genesee County in 1831. He died in Rochester, New York, in 1876.

u contributed by Nancy Muenker

Semiconductors

Used in transistors and integrated circuits, a semiconductor is a type of material such as silicon or germanium that allows electricity to flow through it without much resistance.

Semiconductors were developed in the 1940's because of their potential to replace bulky, unreliable vacuum tubes as a medium for electricity flow and for amplification. Some materials, such as copper or silver, are excellent conductors because they allow electricity to easily pass through them. Other materials, such as glass, allow little electricity to flow through them; they are called insulators. Semiconductors fall somewhere in the middle of the two extremes.

During World War II, over 30 research centers in the United States experimented with materials like germanium and silicon.(Silicon is the most plentiful element on Earth except for oxygen.) Bell Labs, for instance, wanted an inexpensive material that could replace vacuum tubes in its switching centers. Finally in 1947, Bell engineers developed a solid-state transistor using germanium. Silicon, with its melting point of 1450 degrees Fahrenheit, soon became a more standard material used in semiconductors. As electronic components produced less heat and decreased in size, electronic devices swiftly became much smaller, and in the case of radio, even portable. They also became more reliable, since there were no longer vacuum tubes to burn out.

In 1959, an engineer at Texas Instruments, Jack Kilby, harnessed the potential of semiconductors when he integrated a transistor and an oscillator on a germanium wafer. Today, hundreds of thousands, even millions, of electronic components can fit onto a semiconducting silicon chip within an area of one-eighth by one-sixth of an inch.

Silicon has become such an important part of electronics that the epicenter of semiconductor technology, an area just east of the San Francisco Bay area, is known as "Silicon Valley". Early electronics firms that settled in the Valley began to attract the engineering elite from nearby Stanford University. As the semiconductor industry grew, more high-tech companies, such as Hewlett-Packard, Fairchild Camera and Instruments, and Shockley Semiconductors, prospered in the area, attracting the brightest engineers from around the country.

u contributed by Christopher LaMorte

Shapp, Milton Jerrold (1912 – 1994)

American cable television pioneer, electronics engineer, entrepreneur, politician, former Governor of Pennsylvania, playwright and humanitarian. Milton Shapp is best known for the leading position his company, Jerrold Electronics, established as a supplier to the cable television industry and for his tenure as Governor of Pennsylvania from 1971 to 1979.

Milton Jerrold Shapp was born June 25, 1912, in Cleveland, Ohio. In 1933, he received a BS degree in Electrical Engineering from Case-Western Reserve University. An amazing success story, Shapp humbly began his career in 1933 driving a truck. But this effort was short lived. From 1934 until 1937, he was a sales engineer; from 1937 through 1938, he was Eastern Sales Manager for Radiart Corporation; from 1938 to 1942 and from 1946 to 1949, he was President of M. J. Shapp & Co., a manufacturer's representative for several electronics organizations.

With a $500 investment, he started Jerrold Electronics Corporation in 1948 in Philadelphia. The company initially produced tune boosters for television. In 1950, it became a leading supplier of television equipment for early cable television (CATV) systems in Pennsylvania. He initially worked with other cable pioneers, such as Robert Tarlton, who built the first CATV system in Lansford, Pennsylvania and also with John Walson in Mahoney City, Pennsylvania. Shapp invited Tarlton to meet with his design engineers so that they could develop the specific products that Tarlton needed for his first cable system. As it turned out, Tarlton provided the alpha site testing for products that Jerrold developed and marketed.

Because of the work accomplished by Jerrold Electronics for the Lansford CATV system, the company became very well known in the cable television industry. One of the key factors that contributed to Jerrold Electronics' great success was the exacting standards that Shapp instituted for his products. In addition, he insisted on working on the maintenance of cable systems he installed whenever possible and required a 5-year contract. For a portion of the monthly subscriber's fee, his company replaced worn-out parts and provided technical training as well. Today, Jerrold Electronics is well known as a leading supplier of cable television equipment.

In 1951, Shapp worked with American Telephone and Telegraph (AT&T) to negotiate the first contracts to allow cable television companies to share the use of existing telephone poles in order to string cable for delivery of television signals. Also in 1951, Shapp initiated a hiatus in production and sales to completely redesign the equipment and other cable apparatus the company manufactured. In 1952, Shapp expanded his business holdings and began a company to build cable systems throughout the country. He and a group of investors, including Robert Tarlton, acquired several cable systems.

In 1954, Jerrold Electronics Corporation issued an initial public stock offering, and from 1960 to 1963, Shapp was Chairman of the company. It was during this time that the company merged with Harman Kardon Corporation, a manufacturer of high-quality audio equipment. Harman Kardon became a subsidiary of Jerrold Electronics, and Syd Harman was named President of the company. In 1966, Shapp sold Jerrold Electronics to General Instrument, based in San Diego, California. The Jerrold Electronics division remains based in Pennsylvania, however. In late 1994, General Instrument discontinued using the name Jerrold Electronics, and the division is now marketed under the corporate parent's name, General Instrument.

It was in 1960 that Milton Shapp first entered politics. From 1961 to 1963, he served as a consultant on an Economic Redevelopment Program for the Secretary of Commerce in Washington, D.C. During this time period, he helped Sergent Shriver and Hubert Humphrey forge the concept and initiate legislation for the Peace Corps. In 1966, he first ran for Governor of the state of Pennsylvania on the Democratic ticket. Although he didn't win the first time out, Shapp ran again in 1969. He was elected in 1971 and served as the Governor of Pennsylvania until 1979. That year, he formed a new cable television operating company with other partners. He later sold his interest in the organization.

Throughout his illustrious career, Shapp worked with programs for developmentally challenged children. He wrote many articles and books on education and mental health, for which he was honored. In addition, he authored a two-act musical comedy titled *Man of Action.*

Active in the cable television industry, Shapp was a member of the National Cable Television Association's (NCTA) Cable TV Pioneer Club, and was a member of the NCTA Board of Directors from 1959 to 1961. He was a member of the Institute of Electrical and Electronic Engineers (IEEE). He received a number of honorary degrees throughout his lifetime. In addition, he received numerous awards, including a special award from President John F. Kennedy and the Distinguished Service Award from General Mark Sharp.

Milton Shapp died on Thanksgiving Day, November 24, 1994. He is survived by his wife, Muriel, and three grown children. In a tribute to Shapp published in the December 26, 1994, issue of *Cablevision* magazine, John Rigas, cable television pioneer and Chairman and CEO of Adelphia Communications Corporation, wrote: "He was among the five most important people in cable history. He created and often financed the product that kept us in business. Without him, I wouldn't have made it; and neither would a lot of others. He was our hero." A remarkable individual and outstanding public servant, Shapp helped shape the American cable television industry.

u contributed by Valerie Switzer

Shareware, Freeware

Software primarily available through electronic bulletin boards and user groups. Developers of shareware request a nominal, voluntary payment if the software proves to be useful. Freeware is given away free of charge.

Shareware and freeware, also known as public domain software, largely came about as a result of differing opinions concerning the development and protection of software programs.

As personal computers became popular in the 1970's, the need for programs to run them substantially increased. Initially, each computer brand was developed with its own operating system. Because each operating system had its own attributes, application software had to be written for each specific system.

Standards for operating systems were introduced with the first open systems in the early 1980's. These standards were shared by a consortium of computer companies, making it possible for software designed for one computer to run on other computers that shared the same standard.

As the demand for new software continued to grow, concerns were raised over the protection of that software. Many software developers argued for copyright or patent protection, which would give their software the same protection as movies, books, and music. However, such protection did little to stem the growing problem of software piracy, which is estimated to cost the software industry billions of dollars annually.

Other software developers believed software programs should not be treated like private property and that efforts to do so would slow down the development of new programs. They also had little regard for existing or proposed laws protecting the copying of software since such laws were impossible to enforce.

Richard Stallman, a noted "hacker" (someone capable of executing unusual programming feats), believed free programs were the answer. He rewrote several major pieces of software and offered them for free, without any copyright restrictions. Other independent program developers chose to follow Stallman's lead and developed programs that they offered for free or for a nominal charge.

Hundreds of thousands of freeware, shareware, and public domain software programs are today available to the public through such services as bulletin board systems (BBS) and user groups. Freeware developers often retain all rights to their software, preventing users from copying or distributing it further. Developers of shareware require a nominal payment on a voluntary basis, which usually entitles the purchaser to a software manual and updated versions of the program as they are released. Another type of freeware, known as public domain software, offers programs that have been donated for public use by the people or companies that developed them. These programs are available to anyone who wishes to copy or distribute them.

u contributed by Sonia Weiss

Shockley, William Bradford (1910 – 1989)

American physicist, engineer, teacher, and winner of the Nobel Prize in Physics for co-inventing the transistor, which revolutionized electronics.

In 1910, Shockley was born in London, England to American parents. He spent his youth in California and was educated at the California Institute of Technology, Massachusetts Institute of Technology, and Harvard University.

Shockley joined the technical staff of Bell Telephone Laboratories in 1936. During World War II, he left Bell to direct the U.S. Navy's anti-submarine research and became a consultant to the Secretary of War in 1945.

Returning to Bell after the war, Shockley directed transistor physics research. Working with associates John Bardeen and Walter Brattain, Shockley invented the point-contact transistor in 1947. This minute device replaced the bulkier vacuum tube. It was able to switch current on and off much more quickly, generate less heat, use less power, and resist shocks better than its predecessor.

Shockley, Bardeen and Brattain shared the 1956 Nobel Prize in Physics for inventing the transistor, which launched a revolution in microelectronics and greatly reduced the size and cost of computers.

A month after he and his colleagues invented the point-contact transistor, Shockley invented the junction transistor.

During the mid- to late 1950's, Shockley taught at the California Institute of Technology, was deputy director of the Defense Department's Weapons Evaluation Group, and established the Shockley Semiconductor Laboratory with Beckman Instruments, Inc.

From 1958 to 1975, Shockley taught electrical engineering at Stanford University. During this time, he became a controversial figure for his views on intellectual differences between races. William Shockley died in 1989 at Palo Alto, California, at the age of 79.

u contributed by Kay S. Volkema

Sibley, Hiram (1807 – 1888)

American businessman, financier, co-founder and President of Western Union Telegraph Company, and incorporator of Cornell University. Hiram Sibley is primarily known for his role as President of the Western Union Telegraph Company and for spearheading the first transcontinental telegraph line.

Hiram Sibley was born in North Adams, Massachusetts, where he attended the village school and became a shoemaker. As a young man, he started a machine shop and a wool-carding business. In 1838, he moved to Rochester, New York, where he worked in real estate and banking and was elected Sheriff of Monroe County.

In the 1850's, Sibley's financial interests turned toward the burgeoning telegraph industry. When principals of the New York State Printing Telegraph Company approached Sibley to invest in the company's venture to build a line from Buffalo, New York, to St. Louis, Missouri, Sibley agreed on the condition that the company adopt a broader goal: acquisition of all telegraph interests west of Buffalo.

The enterprise reorganized in 1851 as the New York & Mississippi Valley Printing Telegraph Company with Sibley as a major stockholder and its principal promoter. The company's primary objective was westward expansion based on acquisition and consolidation of existing lines rather than on construction of new lines. Despite the telegraph industry's chaotic condition, Sibley managed to raise $100,000 from the skeptical business community in Rochester, New York.

Under Sibley's direction, the new firm launched its campaign to organize scores of small companies under larger operating units. Sibley's astute business acumen triumphed in April 1854, when he negotiated construction of lines to Detroit and Chicago through a contract with the Cleveland and Toledo, the Michigan Southern, and the Northern Indiana railroad companies. In exchange for building and equipping the necessary lines for the telegraph company, the railroads received $125 of telegraph company stock for every mile of line and free use of the lines for railroad business. Thus, without a cash outlay, Sibley acquired telegraphic linkage with two key urban hubs in the expanding West, Chicago and Detroit, and more than 500 miles of additional lines.

The New York & Mississippi Valley Printing Telegraph Company reincorporated in 1856 as the Western Union Telegraph Company with Sibley as President. The company continued to purchase unprofitable firms at nominal prices. By 1860, its lines stretched over parts of 13 states, from the eastern seaboard to the Mississippi and from the Great Lakes to the Ohio River.

When Sibley failed to convince his Western Union associates to build a line to the Pacific coast, he garnered support from industry leaders in the North American Telegraph Association. Together they lobbied Congress, whose enactment of the Pacific Telegraph Act endorsed and subsidized the 2,000-mile transcontinental project. Sibley won the U.S. government bid and with his associates promoted and orchestrated the line's construction. In late 1861, the overland line sent its first telegram. The Western Union Telegraph

Company purchased the transcontinental line in 1864.

Sibley’s next grand project was telegraphic communication with Europe by way of Siberia. Along with Perry McDonough Collins, he planned a line to Russia through Alaska, the Bering Strait and Siberia. The Western Union extended $3 million to build 1,500 miles. The line got as far as the Sheena River in Alaska before successful laying of the Atlantic Cable made the project impracticable.

Sibley retired from the Western Union Telegraph Company in 1869. During his presidency, the company’s property value grew from $220,000 to $48 million.

In later years, Sibley engaged in farming operations, established a seed culture business and invested in salt works in Saginaw, Michigan. He was an incorporator of Cornell University, where he founded the Sibley College of Mechanical Engineering. He also donated a library building, Sibley Hall, to the University of Rochester.

Sibley was married to Elizabeth M. Tinker and had a son and a daughter. He died in Rochester, New York, in 1888.

u contributed by Nancy Muenker

Smart Homes

Houses that are designed to electronically control utilities, services and the living environment functions to meet the needs of the occupants. Smart homes use a single wiring system to deliver electrical power, telecommunications, and television and audio signals. A smart home can provide products (cooked food), services (heat) and information (the bathtub is full) to the occupants. The system performs activities that have been programmed into it, or it can learn the habits of the occupants.

Smart homes have three major components. First is a central controller, such as a computer or hand-held remote control. The controller can be programmed to perform certain functions at the same time each day, for example turning on a porch light, or when certain conditions exist, such as a visitor ringing the doorbell. The second component is a wiring system that provides electrical power, in the form of 120 volt alternating current and 12 volt direct current, and audio, video and telephone signals to each outlet in the house. The third component is the appliances that have microprocessors built into them to communicate with the controller.

Devices and appliances that contain microprocessors, which work like minicomputers, are now used to wake people at the same time each day and start food cooking or thawing. In a smart home, the system controller communicates with these microprocessors, no matter what they are in or where they are plugged into the system.

When a stereo speaker is plugged into the wiring system, the microprocessor in the speaker communicates with the central controller. The microprocessor tells the system that the device is a speaker, not a toaster. The system then sends audio and power to the speaker. If the speaker were unplugged and a television plugged into the same outlet, the system would deliver a video signal and power. Since the wiring system carries all electricity and signals, appliances and electronic devices can be moved any place in the house without changing the wiring, adding an outlet or running additional cable.

Smart homes conserve energy. The homeowner uses less energy, both electric and gas, because utilities are provided only when needed and to do only what is necessary.

In addition to convenience and energy savings, smart homes are safer. For example, if a lamp is off and the power cord is cut, the person who cut the cord is not shocked. No electrical power would be present in the cord until the lamp was turned on. Smart homes can include sensors to cut off gas or electrical power if there is a problem with a device.

A smart home senses a variety of dangers or emergencies, such as fire, water or gas leaks and intruders. In the case of a fire, the system would shut down utilities, open windows or doors, guide people out of danger by a safe route and notify the police and fire departments.

Electronics manufacturers and service providers are working together to adopt a standardized communication link between appliances and controllers. The X-10 communication standard, which has been used since the 1970's, is being replaced by

CEBus, MediaLink and LonWorks. One of these new standards will be used to automate new houses. Experts predict that by the year 2000, there will be 2,000,000 smart homes in the U.S.

u contributed by Paul Stranahan

SBC Communications, Inc.

The regional Bell operating company (RBOC) — also known as a Baby Bell — that was formerly Southwestern Bell Corporation. SBC provides local phone service in five states — Arkansas, Kansas, Missouri, Oklahoma and Texas — as well as cellular, directory publishing and other information services.

The 1984 divestiture of AT&T resulted in the creation of seven regional Bell operating companies (RBOCs), also known as Baby Bells. In the divestiture agreement, Southwestern Bell received local phone service rights in five states — Arkansas, Kansas, Missouri, Oklahoma and Texas — as well as a cellular service provider and directory advertising business. It shares Bell Communications Research (Bellcore) with the other six RBOCs.

In 1993, Southwestern Bell moved its headquarters from St. Louis, Missouri (where it had been based since 1879), to San Antonio, Texas. CEO Edward E. Whitacre, Jr. explained that the move brought the company closer to its customers, 60 percent of whom are in Texas. San Antonio also is considered a gateway to Mexico, where the company has major holdings. Another significant change occurred the following year, when Southwestern Bell was renamed. According to Whitacre, the new name — SBC Communications, Inc. — more accurately reflects the company's diversification from its roots as a local telephone service provider.

A recent Federal Communications Commission (FCC) industry analysis ranked Southwestern Bell Telephone (SBC's telephone subsidiary) first among the seven RBOCs in the quality of service provided to small business and residential customers. Although the company has only six of the nation's 50 largest cities within its region, it handles over 164 million calls daily, and added nearly a half million access lines in 1994 alone. In the area of custom calling features, SBC was the first RBOC to offer automated call completion for customers using directory assistance. After several years of minimal growth in local telephone service, the company is expanding its advertising efforts particularly focusing on younger consumers, who typically use more services such as Call Forwarding and Call Waiting. Voice messaging is another growing, revenue-generating SBC service. The company provides this service to nearly a half million customers in ten major US cities, and it also offers Spanish voice mail service in selected cities. In the area of advanced technology, SBC has installed fiber-optic rings, which protect against outages and enable high-speed data and video transmission, in its largest metropolitan areas. The company expects 75 percent of its switching offices to be converted to digital technology by 1996.

The March 1995 issue of *Business Week* reported that the value of SBC shares (including reinvested dividends) has risen 654 percent since 1984, versus an average of 461 percent for the other six Baby Bells. CEO Whitacre, who is determined to sustain the past three years' double digit returns, credits the performance to unregulated businesses, such as cellular phones and international investments, that currently generate 35 percent of SBC earnings.

SBC has concentrated much of its diversification efforts in mobile communications. Based on its reported three million subscribers, SBC is the world's largest cellular operator, and the company projects that its domestic wireless customer base will grow to eight million by the year 2000. SBC operates cellular systems in over 60 US markets, including six of the nation's top 15 markets. It is investing $2 billion to upgrade its cellular network and to introduce digital service. In addition, the company provides innovative services, such as voice-activated dialing and customized voice messaging. To help expand its cellular operations, SBC continues to develop strategic alliances. For instance, a collaboration with GTE, announced in 1994, will open more Texas markets with 12 million potential customers.

Under Whitacre's guidance, SBC is entering the information highway, but less aggressively than other RBOCs. In August 1994, however, SBC did sign a memorandum of understanding with Walt Disney and RBOC BellSouth to begin planning a joint venture that will create and deliver video services. The coalition plans to eventually market those services to current SBC and BellSouth customers. SBC has also purchased cable systems that serve 230,000 homes in two Washington, D.C. suburbs. In Richardson, Texas, a Dallas suburb, SBC will partner with Microsoft to test video-on-demand services to current telephone company customers. The test project is expected to include services such as interactive games, home shopping and educational programming.

Internationally, SBC is involved in a variety of enterprises. In 1990, the company acquired an interest in Telmex, the Mexican telephone monopoly. Since that time, Telmex has increased its lines by 50 percent and now provides more than 8,000 rural Mexican villages with their first telephone service. In Israel, SBC has interests in directory publishing, cable television and developing multimedia software. It also has an alliance with a privately owned telecommunications company in Chile that provides local, cellular and long distance telephone services; in addition, SBC participates in cellular ventures in France and Korea. In partnership with Cox Communications, SBC operates a United Kingdom cable business. SBC is also part of a consortium of major cable television operators that have joined together to develop cable programming. WireTV, a lifestyle and sports channel, is their first product.

u contributed by Susan P. Sanders

Whitacre, Edward E., Jr. (1941 —   )

American business executive, currently Chairman and Chief Executive Officer of SBC Communications, Inc. (formerly Southwestern Bell), a regional Bell operating company (RBOC).

Edward E. Whitacre, Jr. was born in Ennis, Texas, (a small town outside Dallas) on November 4, 1941. He attended Texas Tech University in Lubbock, Texas, and joined Southwestern Bell in 1963 as a student engineer. The next year, he earned his Bachelor of Science degree in industrial engineering from Texas Tech. During the following years, Whitacre held various operations positions in the company' s Texas, Arkansas and Kansas branches, and he became President of Southwestern Bell's Kansas division in 1983. While in this position, Whitacre led the company through the Bell system divestiture that created seven regional Bell operating companies (RBOCs), also known as Baby Bells. He then moved to RBOC Southwestern Bell Telephone (later renamed SBC Communications, Inc.), where he served as Group President, then Vice President of Revenues and Public Affairs, and later Vice Chairman and Chief Financial Officer. In October 1988, Whitacre was made President and Chief Operations Officer, and in 1990, he was named Chairman of the Board and Chief Executive Officer.

Known for his informal management style, Whitacre is an imposing figure at 6'5" tall. When he was selected as CEO by the board, he was given the mission to " tighten the company's belt." Consequently, he sold three of the company' s seven jets and set a standard for achieving double-digit earnings for shareholders. Whitacre, who retains traces of his Texas accent, moved corporate headquarters to San Antonio, Texas, from St. Louis, where it had been located since 1879. Speculation about the reasons for the move range from the possibility that Whitacre was seeking a more favorable legislative climate to a decision to abandon midwestern formality to Whitacre' s desire to return to his Texas roots. In 1994, the company changed its name to SBC Communications, Inc. to reflect its international, diversified business strategy. Under Whitacre's leadership, SBC is pursuing cable interests less aggressively than other RBOCs, choosing instead to invest in ventures, such as cellular operations, that promise more immediate returns.

In addition to his responsibilities at SBC, Whitacre serves on the boards of Anheuser-Busch, May Department Stores, Emerson Electric, Burlington Northern and Texas Tech University and Health Sciences. He is also a member of the Executive Board of the National Council for the Boy Scouts of America.

u contributed by Susan P. Sanders

Spindler, Michael H. (1942 –)

German-born American business executive, currently President and Chief Executive Officer of Apple Computer, Inc.

Michael Spindler was born and educated in Germany and received his MBA from Rheinische Fachochschule. Prior to joining Apple Computer, Inc., he held management positions at Intel Corporation and Siemens AG and spent eight years at Digital Equipment Corporation. In 1980, Spindler was recruited by Apple to become its Marketing Manager in Europe. Later, he was named General Manager of Apple's European marketing and sales operations, and in 1985 he became Vice President of Apple's international marketing and sales division. Within two years, sales had doubled. In 1987, he was named President of Apple Europe, where he was responsible for the company's 13 European subsidiaries and its distribution network throughout Africa, the Middle East and the Mediterranean area.

In 1990, Spindler was brought to Apple's Cupertino, California, headquarters as President and Chief Operating Officer. In June 1993, Apple's Board of Directors appointed Spindler President and Chief Executive Officer, succeeding John Sculley. Spindler also serves on Apple's Board of Directors.

At an October 1993 sales meeting, Spindler addressed 2,000 Apple sales representatives. He described the difficulties Apple was facing — unprecedented losses and massive layoffs. At that meeting, Spindler, in his heavily accented English, passionately committed to turn Apple around. And he is.

Spindler's stick-to-the-facts management style has earned him the nickname "the Diesel." Since becoming CEO, he has cut costs, improved efficiency and transformed Apple's free-wheeling culture into a more goals-oriented environment. A self-confessed "techie," Spindler has demonstrated his ability to function both as a pragmatic administrator and a creative entrepreneur. Executive strategy sessions are often highlighted by Spindler's effective hand-drawn charts and outlines. Under his leadership, Apple has launched its first all-new Macintosh in a decade and made the long-delayed decision to license Apple technology to other manufacturers.

The result is that Apple's earnings have dramatically improved. The company is focused on business goals that include developing systems to challenge competitors' user-friendly product lines (such as Microsoft's Windows), sustaining its growing business discipline and launching a major advertising campaign.

In addition to his responsibilities at Apple, Spindler serves on two corporate boards — Bertelsmann AG and VidaMedInc., a medical instrumentation company involved in cancer research. He also participates in the Computer Systems Policy Project (CSPP), a 13-member organization of chief executive officers from large U.S. computer companies. CSPP concentrates on public policy issues that influence the technology industry. Spindler chairs its Global Information Infrastructure Council.

Michael Spindler’s intelligence, business know-how and energy speak for themselves as Apple Computer, under his leadership, is adapting to challenging times in the rapidly changing computer industry.

u contributed by Susan P. Sanders

Editor's Notes:
In early 1996, Michael H. Spindler left Apple Computer, Inc. and was succeeded by Gilbert F. Amelio as Chairman and Chief Executive Officer. The shift in power came amid rumors concerning Apple's financial stability and possible negotiations to sell the company. Apple has denied involvement in any merger talks. A. C. "Mike" Markulla will continue to serve as the company's Vice Chairman of the Board.

Sputnik

A series of three artificial satellites launched by the Soviet Union in 1957 and 1958. Sputnik 1 is credited with officially launching the space race between the United States and the Soviet Union.

Developed by German and Soviet rocket scientists in the former USSR, Sputnik (meaning "traveling companion" in Russian) was the name of the very first series of artificial satellites launched from Earth. The initial satellite, Sputnik 1, was launched the evening of October 4, 1957, from Tyuratam, Kazakhstan, under the supervision of Sergei Korolev, the chief Soviet rocket designer. It weighed 84 kg, or 184 lbs. Its scientific purpose, and that of its two successors, was to probe outer space to help scientists determine if organisms from Earth could survive outside of Earth's atmosphere. Sputnik 1 carried a radio beacon and thermometer.

Although the launch of Sputnik 1 was of great importance to the Soviet scientific community, it had a far greater public relations effect for the Soviet Union as a political entity — it was a propaganda coup d'état. Sputnik 1's launch was planned to coincide with the International Geophysical Year (IGY), which had begun officially on July 1, 1957. The IGY was the first coordinated scientific effort of its kind between East and West since the end of World War II. Its goal was to coordinate and showcase the efforts of the world's most noted geologists, oceanographers and atmospheric scientists, and it was an event of tremendous international significance. With the successful launch of Sputnik 1 during the IGY, it seemed that Russia, under the leadership of Soviet Premier Nikita Khrushchev, had won the first phase of the space race. Indeed, the event had a great impact on heating up the cold war.

The launch of Sputnik 1 immediately captured the attention of U.S. space scientists and the U.S. Army, Air Force and Navy — as well as the entire world. However, other notable reactions in the United States were varied. On one hand, President Dwight D. Eisenhower seemed to disregard the event as unimportant and, conversely, the press issued a dismal and depressing commentary on the deficiencies of the U.S. space program. As Project Apollo astronaut Buzz Aldrin later remembered the historic event and the diversely different reactions, he concluded that neither one were accurate. According to Aldrin, although there was a great deal of luck involved in the successful launch of all three of the Sputnik satellites, in light of Russia's very limited experience in rocketry, the launch of Sputnik 1 was an incredibly bold move engineered by Khrushchev.

It is well known that Sputnik 1 was the catalyst for officially starting the space race between the United States and the USSR. From this point on, the United States accelerated its plan for space exploration with the goal of sending man to the Moon. This, of course, was achieved on Sunday, July 20, 1969. Astronauts Neil Armstrong and Buzz Aldrin were the famous "moon walkers" of that historic voyage.

The second Sputnik, weighing more than one-half ton (1,140 lbs., or 519 kg) was launched on November 3, 1957, less than one month after Sputnik 1 had gone into orbit. Its sole passenger was a dog named "Laika," which managed to survive for 10 days.

Thus, Sputnik 2 was successful in proving that animal life could tolerate the weightlessness of outer space.

Slightly more than six months later, on May 15, 1958, Sputnik 3 was launched. It weighed nearly one and one-half tons, and, according to published reports, carried a variety of instruments intended to measure radiation. The launch of Sputnik 3 also captured the attention of the United States as it demonstrated that the Soviets could successfully launch a rocket that could carry a very heavy payload — or possibly a very heavy warhead.

In addition to the first three satellites previously noted, there were seven other Soviet spacecraft launched under the Sputnik title. Their purposes were to function as test prototypes for the Soviet manned spacecraft called Vostok (meaning “the East” in Russian) or as possible platforms from which the USSR could eventually launch spacecraft to explore the planet Venus. Thus, Sputniks 4, 5, 6, 9 and 10 were forerunners of the USSR’s upcoming manned spacecraft series, and Sputniks 1 and 8 were slated for use in the Soviet Union’s planned exploration of planets in Earth’s solar system.

u contributed by Valerie Switzer

Strowger, Almon Brown (no dates available)

American undertaker and inventor, known for devising the automatic exchange dial telephone system.

Strowger was an undertaker in Kansas City, Missouri, who was frustrated with the telephone operator system of the 1880's. He suspected that the local operator was tampering with his company's telephone service and diverting calls to her husband's undertaking business.

After studying an earlier unsuccessful patent, Strowger devised a central office switching system between 1889 and 1891. Using electromagnetic stepping switches, it worked without operators and offered 99 different telephone numbers for its subscribers to dial. In 1891, he founded the Strowger Automatic Telephone Exchange to handle his invention. The first public automatic switching telephone exchange was installed in La Porte, Indiana, the next year. Milwaukee, Wisconsin followed in 1896.

Strowger's company was absorbed into the Automatic Electric Company of Chicago in 1908. Eight years later, the company sold the rights to manufacture Strowger's automatic dialing equipment to AT&T's Western Electric. From then on, his system was the accepted technology in all Bell systems, although he did not live to see it.

In 1919, Norfolk, Virginia, was the first large exchange installed with Strowger's system. New York City was finally completed in 1940. Some exchanges based on Strowger's system are still in use today, over a century after its invention.

u contributed by Kay S. Volkema

Superstations

Local broadcast television stations whose signals are distributed nationally via satellite to cable television systems.

In December 1976, the first superstation, WTCG-TV, was distributed via the Satcom satellite. WTCG (later changed to WTBS) was owned by the Turner Broadcasting System. Although Ted Turner was the first cable television entrepreneur to offer a superstation, credit for the idea of bringing a local station to a much larger audience belongs to Bob Wormington. In 1973, he used microwave relays to distribute Kansas City station KBMA-TV to a regional audience.

Superstations were one of the changes in cable television that followed the successful use of satellites by Home Box Office (HBO) in 1975 to distribute movies to cable systems. Since a broadcast station was prohibited by Federal Communications Commission (FCC) rules from leasing transponders and using them to increase its audience, Ted Turner arranged to have the Southern Satellite System created as a common carrier. Under FCC rules, common carriers could lease transponders and distribute a channel nationally, with or without the consent of the television station.

WTBS now has the largest customer base of the superstations, with an audience of approximately 60 million viewers in the United States and additional viewers in Canada and Mexico. The Southern Satellite System charges cable operators a per-subscriber-fee for the WTBS signal, and the superstation charges higher rates for advertising based on its large audience.

By 1979, there were two other superstations, although both of them — WGN of Chicago and KTVU of San Francisco — were distributed nationally without their consent. Later, WWOR of New York City and WPIX and KTLA of Los Angeles also became superstations. In addition, several religious channels distributed by satellite were classified as superstations.

Superstations generally rely heavily on movies, reruns of popular series, and live sports programming to attract viewers. For example, WTBS carries all of the games played by the Atlanta Braves, a baseball team owned by Ted Turner. Likewise, WGN carries all of the baseball games of the Chicago Cubs. Both stations broadcast many classic and recently released movies. WTBS has also produced some first-run programming, including movies and documentaries.

Superstations have expanded the variety of programming offered by cable television systems and have become profitable for their owners. They are an example of how communication satellites have made the world smaller.

u contributed by Paul Stranahan

Tarlton, Robert J. (1914 –)

American cable television operator and pioneer. Tarlton's company, Panther Valley Television Company Inc. (PVTV), began operating in Lansford, Pennsylvania in 1950.

Tarlton was interested in engineering and electronics from an early age. In 1924, when he was ten, and radio was in its infancy, he began installing and servicing the early radio receivers. Tarlton graduated from Lansford High School in 1932, furthering his education in numerous electronic schools. With his father, he established a radio and electronics sales and service business in Lansford, operating it from 1933 until 1950, except for military service during World War II when he was a communication technician in the 5th Army in the Italian theater from 1943 through 1945.

With the advent of television broadcasting in 1946, Tarlton began selling and installing TV receivers in the Lansford area. The only television then available in the area was from Philadelphia TV stations. But because of the community's geographical location, deep in a valley, Lansford residents were unable to receive those television signals with a conventional roof-top antenna. To enable those residents to enjoy television, Tarlton began duplicating a technique that was being used elsewhere in the country in other TV blacked-out mountainous areas. He installed individual TV antennas on hills surrounding the community and extended receiving antenna transmission wire, often thousands of feet, to the owners' TV sets. But those early antenna extension efforts directly benefited mostly those residents on the perimeters of the community; extending TV transmission wire across streets presented many problems. Reception from those individual antenna installations were, at best, undependable, and the installations were relatively costly to install and maintain.

In 1949, Tarlton experimented with apartment house master TV antenna equipment manufactured by Jerrold Electronics Corporation. With modifications Tarlton adapted that equipment to operate as a community master TV antenna system using coaxial cable for transmission and distribution of the TV signal. Information concerning what Tarlton was doing came to the attention of Milton Shapp, president and founder of Jerrold Electronics. After consultation with Tarlton, Shapp ordered his engineering staff to design and manufacture equipment to satisfy the requirements of the community-type systems. Much of the early Jerrold equipment was field tested and critiqued in Tarlton's early system.

Tarlton secured additional investors to assist financing his new idea, the Panther Valley Television Company, Inc. Tarlton was elected its president and in May 1950 began installation of what is now acknowledged to be the first commercially viable, multi-channel coaxial cable television system in the country and in the world. PVTV's first subscribers paid $100 each for the initial connection and $3 each month. Articles in *The Wall Street Journal, Newsweek* and *Television Digest* in January 1951 all documented the new Lansford PVTV system, and generally heralded the new era in television broadcasting.

In 1952 Tarlton joined Jerrold Electronics bringing his experience to Jerrold in constructing and operating a cable TV system. He served in various capacities with that company, including Chief Field Engineer, Service Manager, CATV Construction Installation Manager and Community Operations Manager. During the four-year period he was with the company, he was directly responsible for the construction and operation of many of the early cable TV systems located throughout the country.

Tarlton left Jerrold in 1956 to devote more time to the expanding PVTV and to his consulting business. His company, PVTV, was bought by a major cable operator in 1970 and merged into that company.

Tarlton, as one of the most respected men in the cable industry, was co-founder of the National Cable Television Association (NCTA). Very active in the organization, he was Director for many years, involved in committees, and the recipient of various prestigious awards. He also founded the Pennsylvania Cable Television Association (PCTA), was its first president, later serving as its Executive Director and lobbyist, and was elected a founding member of both the National Cable Pioneers and the Pennsylvania Cable Pioneers Associations. He and fellow pioneers, such as Martin Malarkey and Ed Parsons, would gain fame as not only the first individuals to bring television to inaccessible markets, but also as those who helped create the structure of the entire industry, including many of its financial and political aspects. Undoubtedly cable TV systems would have developed without these visionary men; but the industry operation owes much of its foundation, format and basis to men like Robert Tarlton.

u contributed by Michele Messenger and Robert J. Tarlton

Tele-Communications Inc. (TCI)

Founded in 1956, TCI is the largest multiple-system cable television operator (MSO) in the United States. As of July 1995, it is comprised of approximately 4,000 franchise systems serving more than 12.7 million subscribers in the continental United States. Its corporate headquarters are in Englewood, Colorado. Through its subsidiary Tele-Communications International, Inc., TCI also has interests in cable systems in several foreign countries. In 1994, it entered into cable joint ventures in Japan and Argentina.

Tele-Communications Inc., widely known as TCI, has its roots in rural west Texas, building its first cable system in Memphis, Texas, in 1956 by Bob and Betsy Magness. A cottonseed salesman and part-time cattle rancher in Oklahoma, Magness had the good fortune to run into a group of people who had just built their first cable system in Paducah, Texas. The idea of investing in the young cable television industry captured the imagination of Magness. So much so, in fact, that he and Betsy sold their cattle and re-financed their home in order to invest in a cable TV system.

Soon after, their first cable system was up and running in Memphis with more than 700 subscribers. Bob actually installed the cable on poles, and Betsy ran the business management side of the operation. Shortly thereafter, they expanded their business to the community of Plainview, Texas, where they acquired an additional 3,000 customers in this second venture.

In 1958, they joined forces with Jack Gallivan of Reno, Nevada, and George Hatch and Blaine Glasmann, television entrepreneurs in Salt Lake City. This association resulted in a new partnership to bring cable to Montana. Bob and Betsy moved to Bozeman, Montana, and were successful in launching this new endeavor. By 1965, the partnership had developed a total of six systems with more than 12,000 customers.

Needing a more centralized location, the Magnesses moved the company to Denver that same year. The relocated operation had a total of 12 employees and was actually comprised of two different entities: Community Television, Inc., the cable company, and Western Microwave, Inc., which was a microwave common carrier. In 1968, both organizations were joined under one umbrella company, thus creating TCI.

In the years that followed, the company overcame several challenges and continued its consistent growth. By 1970, it was the tenth largest cable company in the United States. It issued its first public stock offering in the same year, raising nearly $6.7 million.

In 1972, Dr. John C. Malone joined TCI. Prior to joining the organization, he had been President of Jerrold Electronics, now a division of General Instrument. In 1973, Malone was named President and Chief Executive Officer of TCI, with Magness becoming Chairman. Known for his ability to negotiate favorable contracts, Malone realigned the company’s debt load, and, under his skillful direction, TCI successfully acquired many other cable operations throughout the country.

By 1975, the company had grown significantly, becoming the second largest cable operator in the United States, with 651,690 subscribers through ownership of 149 cable systems in 32 states. During the late 1970's and 1980's, TCI continued its expansion through a variety of acquisitions, joint ventures and construction.

The company celebrated a significant milestone in 1982, when it became the country's largest cable operator, having established a subscriber base of two million nationwide. In 1984, Western Tele-Communications, Inc. was realigned as its own separate company. Four years later, it merged with Marcus Communications and was renamed WestMarc Communications, Inc. In order to become more cost efficient, the two companies merged once again under the TCI umbrella in 1989.

The year 1984 was significant for TCI in other ways. Its rapid growth continued with expansion into several major U.S. cities. These included Buffalo, New York, and Pittsburgh, Pennsylvania, via new agreements with both cities. In Chicago and St. Louis, TCI built cable systems and in Washington, D.C., TCI became a major investor in the existing system. It was in 1985 that TCI secured a greater portion of ownership in Group W Cable, which was at the time the nation's third largest cable operator. In the early 1990's, TCI acquired Heritage Communications, which had a total subscriber base of more than 975,000. Late in 1991, TCI finalized its acquisition of United Artists Entertainment (UAE). This transaction alone added 86 cable systems to TCI's operations, along with several foreign cable investments.

Always mindful that the company would need various programming options, Malone led TCI to invest in a wide variety of entertainment services. TCI invested in the Black Entertainment Television Network (BET), Cable News Network (CNN) and the Discovery Channel. It also created Liberty Media Corporation. In 1991, Liberty's Encore service premiered, offering a variety of adventure, romance and Western films that gave TCI subscribers additional programming choices. In 1993, STARZ! made its debut, providing even more feature movie choices.

Also in 1993, TCI and Bell Atlantic announced what would have been one of the largest corporate mergers in the history of the United States. Published reports valued this planned merger at between $30 and $32 billion. However, due to various circumstances, including the continued freeze on cable rates announced by the Federal Communications Commission (FCC) in February 1994, the merger was called off by both parties.

In late 1994, TCI announced its reorganization of the company into four operating groups. These groups have four distinct areas of responsibility: domestic distribution of cable and telephony; programming; international investments and operations; and technology ventures.

In the effort to provide its subscribers with interactive, full-service broadband networks throughout the country, TCI premiered its National Digital Television Center in Littleton, Colorado, in 1993. The Center converts analog signals to digital, allowing the distribution of digitally compressed programming to cable systems and home satellite receivers nationally. TCI's direct broadcast satellite (DBS) service, marketed nationally under the name PRIMESTAR, currently has more than 250,000 subscribers. In addition, in mid-1995, TCI announced @Home, a cable-based interface service to the Internet.

TCI's community service efforts include the TCI Education Project, offered as a service for teachers, students, administrators, school board members and parents. The TCI Education Project includes the J. C. Sparkman Center for Educational Technology, a staffed facility located in the National Digital Television Center, whose main purpose is to train educators and related audiences in effective uses of new and emerging technologies.

Having targeted international expansion as an important area of growth, TCI is also involved in a number of joint ventures outside the United States. A partnership known as TeleWest, a joint venture with U S WEST, is ongoing in the United Kingdom. TCI is also involved with Sumitomo Corporation in Japan. In December 1994, TCI finalized an agreement with Argentina's CableVision, the country's largest single cable operator, with a base of over 420,000 subscribers.

In addition, TCI has a number of test projects in progress throughout the United States. In Seattle, it has launched an interactive cable test with Microsoft, and in Arlington Heights, Illinois, it is involved in a test project with Teleport Communication Group and Motorola, which will offer local telephone service via TCI's cable network. Noteworthy is TCI's 1994 agreement with Sprint, Comcast Corporation and Cox Enterprises, which entails plans to bundle local telephone, long-distance and wireless communications with cable services into a single system for residential customers and businesses alike.

TCI is also in the process of installing and upgrading the fiber optic cable architecture throughout its entire cable network in the United States. This upgrade is one more step in TCI's technological mission to be one of the first cable operators to bring the information superhighway to the consumer in a cost-effective way. In addition, TCI actively supports Cable Television Laboratories, Inc. (CableLabs) in its high definition television (HDTV) research and other major research and development projects intended for the advancement of the cable television industry. In fact, it was CableLabs that issued the "request for proposal" (RFP) in mid-1994 for future cable telephony services on behalf of TCI and five other member cable companies. Malone is currently Chairman of the Board of Directors for CableLabs.

With more than 24,000 employees and continuing international expansion, TCI is poised to retain its leadership position in the telecommunications industry.

u contributed by Valerie Switzer

Editor's Notes:
A number of major companies are working together to develop Intercast technology, an interactive data delivery medium conceived by Intel. The Intercast Industry Group's goal is to create a service which combines television technology with the World Wide Web, allowing end-users to jump between television shows and web pages with the click of a button on a remote control. Companies involved in the effort include Intel Corporation, Continental Cablevision Inc. (under the ownership of US West), Tele-Communications, Inc., Time Warner Cable Programming, General Instrument Corporation, TCI's Headend-in-the-Sky, NBC, Turner Broadcasting, Viacom International, WGBH Educational Foundation, QVC, America Online, Asymetrix, En Technology, Netscape Communications Corporation, Gateway 2000, and Packard Bell.

Telecommuting

The practice of using communications technologies to work at a site often a home office away from the corporate office. Telecommuters are those who use technology rather than traditional ways to go to work. They typically use telephones, fax machines, computers and modems at a remote location to connect to a central or corporate office. In effect, telecommuters commute by way of telephone lines instead of roads.

Telecommuting and telecommuters are found in a wide variety of jobs, such as data entry or consulting; creative endeavors, such as composing or writing; and jobs that by definition call for the individual to be regularly out of the office, such as a manufacturer's sales representative or a real estate agent. With recent technological advances, however, the definition of a telecommuter has become somewhat more specific and usually refers to a person whose employer has allowed or encouraged him or her to conduct daily work responsibilities from an off-site location (usually the employee's home). The average telecommuter spends one to two days per week in the company office and the balance in a home or remote office.

The tools of a typical telecommuter include a personal computer linked or networked to the main office computer network and all of its data, resources and software; a modem to send and receive computer-generated files; a facsimile (fax) machine to send and receive information from other sources; electronic mail (E-mail), which may include an Internet hook-up to send and receive messages and gather data; and voice mail to send and receive detailed voice messages. Telecommuters may also employ a laptop or notebook computer for the times when they are out of their home offices. With the advent of integrated services digital network (ISDN), which allows for more complex data to move at high speeds over telephone lines, telecommuting has become more efficient for employees who need access to a lot of information in a timely manner.

Some of the pioneering telecommuting companies have set up remote office sites for a number of telecommuting employees in a particular area. These sites, which are a cross between a home office and a corporate office, often provide more advanced technology such as teleconferencing, which enables employees at different physical locations to meet via video monitors. Remote sites also usually include an administrator as well as copy machines and other business equipment that an employee is not likely to have at home. These sites can also provide a place for meetings with a client or customer. These amenities allow a telecommuter to work in efficient real time, rather than simply compiling a list of things to be done later or by someone else.

Telecommuters have many faces: the employee who works best if left alone; the one whose job calls for little interaction with fellow employees; the individual who desires to live someplace else (in a community or area that would normally be too far to commute from); the worker who has grown tired of the commute; or the employee who has additional family responsibilities, such as child or elderly parent care.

The pros and cons of telecommuting are sufficiently important for both the employee and employer that many companies have held off implementing telecommuting arrangements while attempting to work out the logistics. Interestingly, but not surprisingly, California companies are leading the way for large numbers of telecommuters but not necessarily because they have worked out all the bugs. The San Francisco and Los Angeles earthquakes in 1989 and 1994, respectively, left many offices uninhabitable and roads unpassable, so the state encouraged employers to allow employees to work from their homes. Following the Los Angeles earthquake, for example, Pacific Bell and GTE California each waived installation charges when adding businesses services, such as voice mail or fax lines, in the homes of the new telecommuters.

Extreme cold weather along the East coast and in the Midwest during the winters of 1993 and 1994 was also an impetus for companies to set up telecommuting arrangements for certain employees. Pollution is yet another contributing factor. Thirteen counties in 11 states throughout the country were forced to comply with the Clean Air Act of 1990 by November 1994, and a rather simple and effective way to cut down on pollution is to either put more people in each car (carpooling) or take more cars off the road via telecommuting. The larger companies in many polluted regions have explored and implemented telecommuting packages that include everything from buying equipment for employees to setting up remote office sites.

The benefits of telecommuting for the majority of employees, besides the obvious easy commute, are an increase in production; a more flexible schedule, frequently allowing for better family relationships; a wider selection when it comes to a home location and schools; and a better sense of control and balance over their lives. The pros for employers are happier and more productive employees; a reduction in office space and expenses; sometimes a decrease in employee benefits; often less capital investment, since many telecommuting employees may have some or all of the equipment necessary to work from home; and a wider pool of talent from which to draw, including workers who, for physical reasons, simply could not make a traditional commute.

The drawbacks of telecommuting for some employees include a sense of loneliness, lack of motivation, isolation and distraction. Some employees also work too much, since the work is almost always accessible. The drawbacks for employers may include ongoing (if unspoken) questions about productivity, lack of accessibility, lack of control, and less oversight of employees' habits. Telecommuting requires discipline in the employee to start and stop work at appropriate hours, trust between employer and employee that the employee is working and that the employer has not forgotten the worker, and communication to and from both.

Many telecommuters underestimate the need for and benefit of business socializing and face-to-face contact. Telecommuters frequently drive to the main office one or two days per week, not only to do the work that can only be done in the office, but also to see and share information with colleagues. Telecommuting is certainly not for every job, every employer or every employee. However, the statistics on the ever-growing number of telecommuters are on the positive side. The majority of employees who are suited to telecommuting are happier and more productive than traditional commuting employees, and the majority of employers invest less and spend less per telecommuting employee.

A rocket scientist turned author first used the word telecommuting. In 1973 author Jack M. Nilles first used the term when describing a solution to the increasing traffic problems clogging the southern California freeways. Nilles wrote a book about the concept of telecommuting and has since written a how-to book for employers and employees. He so firmly believes in the concept that he is now President of JALA International Incorporated, a telecommuting consulting firm. And, a sure sign of an emerging trend, is that some people have re-worked the word telecommuting to telework, which they think better describes its meaning. Because the term is so broadly used, it is difficult to pinpoint the exact number of telecommuters. The most reliable sources estimate that approximately one third (39 million) of the U.S. working population does some work from home. This includes part-time and full-time home-based businesses, people who bring work home to do at night, and telecommuters. Of the 39 million, six to seven million people are considered true telecommuters — people with electronic connections and who work at home for their employers. A 1992 report conducted by GTE Telephone Operations states that telecommuters are mostly married, have minor children, work in white-collar professions, and are 35 to 45 years of age. Another study claims that telecommuters are mostly found among double-income families. As more and more people join the ranks of telecommuters, statistics like these will come to include countless individuals in a wide variety of jobs, industries and circumstances.

Those who predict the future say we will all work in a paperless office, have a lot more free time, and use wireless technology in our everyday lives. The reality may be a less-paper office, flexible — not free — time, and technology overload. However, one trend that is likely to change the way work is accomplished is telecommuting. The office will not be confined to space within company walls. The office will be the place we have chosen to work from in order to maintain a balanced, productive life.

u contributed by Michele Messenger

Telecourse

An educational course or presentation delivered via cable television, satellite, broadcast television or videotape.

Telecourses are either singular video presentations or a series of presentations that make up a course of study delivered to a student. Usually, the student is geographically remote from the instructor; however, telecourses are sometimes used as an adjunct to classroom instruction.

Methods of transmission for telecourses include cable television, satellite systems, broadcast television or pre-taped videos that students may borrow, purchase or obtain through a library.

A crucial distinction among telecourses is the level of interaction that the student has with the instructor and with other students. It is generally agreed that telecourses have maximum effectiveness when students are able to have two-way communication with their instructor or others involved in the course of study. One traditional way to achieve this is through paper-and-pencil work exchanged between the teacher and the student. Other methods include the telephone and more advanced communications technologies, such as electronic mail (E-mail).

Providers of telecourses include traditional colleges and universities, regional educational consortiums, the Public Broadcasting Service (PBS) and even cable television companies. For example, in late 1987, Glenn R. Jones — one of cable television's pioneers — launched Mind Extension University (ME/U), a cable television network dedicated exclusively to distance education telecourses. ME/U offers for-credit degree programs, as well as personal and professional development classes.

Telecourses are one of the most popular types of distance education. In the United States, an estimated 30 million enrolled students (primary through post-graduate) currently participate in some form of distance education.

u contributed by Susan P. Sanders

Telephones: History and Development

The development of the telephone forced a new way of thinking about communications. Just ten years after the telephone was first demonstrated in 1876, there were some 167,000 in the United States. Twenty-five years later there were almost one million. By the 1920's the phone had become a common item in almost every home and business. Currently, the telephone has become a link to the rest of the world and has opened up unlimited information resources. Thousands of technological innovations are the direct result of the work done in the telephone industry. In this article, the technology will be listed separately for each major period of history.

In the Beginning (1876)
For the first hundred years, the history of the telephone was basically the history of the American Telephone and Telegraph Company (AT&T). The origins of the telephone began with attempts to invent a multiplex telegraph; in other words, a telegraph that could send more than one message simultaneously over a single wire. Alexander Graham Bell, a teacher of the deaf and a professor at the School of Oratory at Boston University, was one of several men working independently on the problem. In 1860, Bell invented the harmonic telegraph, a form of multiplex telegraph. Bell realized that a similar device could transmit voice signals, and on February 14, 1876, he filed for a patent on a telephone system. With the help of Thomas A. Watson, Bell was able to perfect his telephone device, and on March 10, 1876, Bell successfully transmitted the sentence Mr. Watson, come here, I want you, to his friend in another room .

The New Company (1877 to 1907)
Following the successful demonstration of his telephone, Bell and his partners founded the Bell Telephone Company in 1877 and hired Theodore N. Vail to run the company . Vail had a vision of universal telephone service, a vision he believed could only be realized by one company serving all of the country's telephone needs. This view would be the basis of AT&T's service philosophy for the next 100 years. The Bell Company bought controlling interest in Western Electric from Western Union, and in February 1882, Western Electric became the sole supplier of Bell equipment and a part of the Bell System.

In 1885, the Bell Company relocated to New York City and reorganized under the name American Telephone and Telegraph (AT&T) with the Bell operating companies as separate subsidiaries. Financial struggles plagued the company and, with the expiration of the Bell patents in 1893 and 1894, the telephone industry was overrun with independent companies, primarily in rural areas. By 1907, almost half of the six million telephones in the country were owned by companies other than AT&T.

Technology (1877 to 1907)
During this time period, amazing discoveries were being made as the telephone industry evolved. First, the telephone transmitter was improved using designs from Elisha Gray and Thomas Edison. The resulting telephone device became the basis for modern telephones.

Second was a discovery in 1881 by a young Bell engineer named John J. Carty, who proposed replacing the one-wire, earth-grounded circuits with insulated two-wire circuits (also called metallic circuits). This eliminated ground interference and improved the quality of the transmissions.

The Bell Company also developed the first practical underground cable, called the dry core cable. Instead of using wax, resin or oil that had proved unsuccessful in the past, the wires were insulated with crumpled paper and air and encased in lead.

Another major improvement resulted from the need to connect all the phones together. The solution was a switchboard. The first commercial switchboard went into operation in New Haven, Connecticut, in 1878. The earliest switchboards, called crossbar switchboards, consisted of a grid of crisscrossing metal strips that were manually connected. The first operators were young men, but they were quickly replaced by polite, young women who proved to be more reliable. As more people obtained telephone service, multiple switchboards were developed that allowed an operator to connect any of the hundred or so subscribers for whom she was responsible to another operator who was handling the party being called.

A subsequent switchboard problem was solved by a Kansas City undertaker, Almon B. Strowger. Strowger created an automatic switchboard that responded to buttons pushed at the telephone set. The number of pushes on the button caused relays to close, establishing the circuit. It also heralded the coming of number assignments to telephone customers. The first automatic switchboard was installed in La Porte, Indiana, in 1892.

Probably the greatest technological advance in the 1880's was the establishment and rapid growth of long-distance service. The first public long-distance line covered the 45 miles between Boston and Providence, Rhode Island, in 1881. The interference on this single, grounded wire was so bad that it would have been a failure if not saved by the two-wire metallic circuit developed by John Carty. Three years later, in 1884, commercial long-distance service was established between Boston and New York City when it was discovered that hard-drawn copper wire, although weaker than the galvanized iron previously used, caused less signal loss and, therefore, could span longer distances.

Not only did the signals lose strength as they traveled longer distances, but they also became distorted. AT&T found a partial solution to this problem in the loading coil invented in 1894 by Michael Pupin, a professor at Columbia University. Loading coils placed on the wires every mile or so offset the natural capacitance (storing of electrical charges) that occurs in very long lengths of wire and interferes with the signals. The use of loading coils allowed thinner wire to be used over longer distances.

One last problem was solved in 1888 when Hammond V. Hayes, an AT&T engineer, developed the common-battery system. This made it possible for a central switchboard battery to supply current to virtually all of the telephones connected to it, making it unnecessary for each telephone to have its own battery.

A New Direction (1907 to the 1920's)
By the early 1900's, AT&T was feeling the effects of hundreds of competitors taking advantage of the fact that the Bell patents had expired, and the telephone industry had now become a free-for-all. In 1907, the struggling AT&T company was taken over by a group of New York bankers led by J.P. Morgan, who reorganized and refinanced the company. Morgan and the company's president, Theodore Vail, shared a common goal:

universal service from one company. Over the next decade, Vail transformed the company into a public-spirited, customer-oriented firm that provided the vast majority of telephone service in the United States. Three elements that contributed to this change were the acquisition of independent companies, the steadfast refusal to let other companies connect to the AT&T network, and an emphasis on research and development. Believing that telephone and telegraph were parts of the same business, Vail also pushed AT&T to buy Western Union and make it part of the Bell System. And in 1911, Vail consolidated the hundreds of local companies acquired by AT&T into state and regional companies.

Many of the independent telephone and telegraph companies complained about AT&T's aggressive acquisitions and refusal to allow connection to their network. In 1912, the Department of Justice (DOJ) started legal proceedings against AT&T. Vail decided a compromise was necessary. The compromise, known as the Kingsbury Commitment, had three major provisions: 1) Western Union would return to independent company status with no tie to AT&T; 2) AT&T would not purchase any more independent companies without the approval of the Interstate Commerce Commission (ICC); and 3) independent companies would be allowed to connect to the Bell System long-distance lines. The direction of the telephone industry was set for the next several decades.

Technology (1907 to the 1920's)
During the first twenty years of the new century, telephone technology took another giant leap forward. It came in two forms: transcontinental phone lines and multiplexing. In 1906, Dr. Lee de Forest described a three-element vacuum tube that could not only generate and transmit sound waves, but could also amplify them. The first vacuum-tube repeater (amplifier) in commercial service was installed at Philadelphia, in the New York to Baltimore line, in October 1913. Then work began on the first transcontinental line. Final wires were connected at the Utah-Nevada border on June 17, 1914; the line was tested on July 29; and coast-to-coast long-distance was formally opened by Alexander Graham Bell in New York City and Thomas A. Watson in San Francisco on January 25, 1915 (Thomas A. Watson, front row, third from right).

Because the cost of copper wire was high and long-distance lines were now a reality, AT&T needed to find a way to send many signals on one line, the same multiplexing problem that had faced the telegraph operators years before. Efforts to multiplex telephone conversations first began in the 1880's. In 1917, the electrical band-pass invention made it possible to multiplex several signals over a single telephone circuit, but there was still a problem with distortion of some signals.

Regulation and War (1920's to 1945)
The 1920's were a time of growth and discovery for AT&T. The growing radio industry interested the company for awhile and, from 1922 to 1925, AT&T owned a national network of 17 radio stations. From the mid 1920's to the mid 1930's Western Electric developed and marketed equipment that synchronized sound and pictures. By 1929, AT&T boasted that Western Electric's sound equipment was used in the making of 90% of the day's talking pictures. And in 1930, AT&T purchased the Teletype Corporation, a company that transmitted typed messages over leased telephone wires. Teletypewriter exchange service (TWX) soon became an important AT&T service.

AT&T's movement into so many different fields, coupled with its domination of the telephone market, raised concerns in many industries and the federal government. In

1934, a Communications Act was passed that created the Federal Communications Commission (FCC) with jurisdiction over telephones and other forms of communication. This marked the beginning of serious federal regulation and supervision in the communications field.

Like everything else in the world, the growth and development of AT&T was put on hold during World War II. Beginning in 1942 and continuing until 1945, Bell Laboratories, AT&T's research arm, and Western Electric, AT&T's manufacturing group, devoted themselves almost entirely to military work, much of it secret.

Technology (1920's to 1945)
Along with its interest in broadcast radio, AT&T also began experimenting with radio-telephony. De Forest's vacuum tube had opened the door to radio-telephony and, in the 1920's, Bell Lab engineers began experimenting with long-distance radio transmission of telephone signals. Overseas radio-telephone service was introduced commercially between New York and London in 1927. But the voices were often barely intelligible because of distortions and static.

At the same time, AT&T was looking at bridging this water gap with underwater cables. In 1923, the first short-distance submarine cable was used successfully between Los Angeles and Santa Catalina Island, a distance of 25 miles. Although transatlantic telegraph service had been in operation since the 1850's, distortion problems and signal strength loss prevented long-distance telephone service from using the same types of lines.

It was becoming increasingly obvious that the standard two-wire copper telephone wire, although a viable medium for short-distance transmissions, was limited in what it could do. In 1934 a radically new form of transmission cable was produced. Coaxial cable consisted of a single wire separated from, but surrounded by, a second conductor. This new cable could carry more signals with less signal loss for greater distances. In 1936, the first Bell coaxial cables were put into service in New York City. Coaxial cables were also capable of carrying television signals, and in 1940 they made it possible for the Republican National Convention in Philadelphia to be televised by NBC in New York.

In addition to improving line quality, AT&T worked on upgrading its switching technology. With the new automatic switching systems of the 1900's in place, the Bell System began offering dial service to its customers in 1921. But not until the 1930's did automatic switching and dial service become widespread. In 1938, the Bell System introduced the first crossbar switching office in Brooklyn, an advancement over the mechanical step-by-step offices and a gateway to the electronic switching offices of the future.

Two other breakthrough inventions from Bell Labs during this time were Harold Black's negative-feedback amplifier and Herbert Ives' transmission of pictures. Black's amplifier made it possible to multiplex signals over longer distances. In the 1930's, AT&T introduced lines that could carry 12 channels each. For years, these lines formed the backbone of AT&T's low-volume telephone circuits.

In 1923, Ives and several associates combined the photoelectric cell with the vacuum-tube repeater to produce the first commercial system for rapid transmission of pictures over telephone wires. Although designed to send still photos for the national press, it laid the foundation for transmitting moving pictures. In April 1927, the first phone to transmit pictures as well as sound was demonstrated when Secretary of Commerce Herbert Hoover placed a call from Washington to New York, where he was seen as well as heard. The first demonstration of a two-way video telephone took place in 1930 , but poor quality and lack of public interest stalled further development of this technology for several decades.

After the War (1945 to the 1960's)
The first postwar surprise for the telephone industry as a whole was the increasing demand for telephone service. New phones were installed at a rate of over 25 per minute every working day during 1946. The demand for instant information was a necessity during wartime and people weren't about to give it up when peace was established.

In addition, many of the technologies developed in secret for use during the war also had application to the telephone industry. New projects at Bell Labs began to produce important advances in telephone technology.

In January 1949, the Justice Department decided that AT&T's ownership of Western Electric and refusal to do business with any other supplier constituted a violation of the Sherman Antitrust Act. The resulting lawsuit dragged on for several years. An agreement was reached in December 1955 and on January 12, 1956, a consent decree was approved in U.S. District Court. Its provisions were long, complicated and technical, but the most important of them included: 1) Western Electric would not be separated from AT&T; 2) Western Electric, except for its government defense work, agreed to confine itself to manufacturing equipment for the telephone market only; 3) the Bell System agreed not to engage in any business other than common-carrier communications and incidental operations; and 4) the Bell System agreed to grant nonexclusive licenses and related technical information to any applicant on fair terms.

AT&T realized it needed to modernize the telephone industry or some other company would. So, in the mid 1950's AT&T started offering colored telephones; and, in 1959, the Princess telephone, a light, colorful set designed to appeal to female customers, was introduced in selected areas. By 1960, dial service was available to 97% of Bell subscribers. In 1963, touch-tone service was launched, featuring telephones with push buttons instead of dials. In the same year, direct long-distance dialing was available to 80% of Bell customers. And in 1965, the Trimline phone with the dial (or touch-tone keypad) built into the handset became an immediate success.

For business customers, AT&T developed Centrex, which enabled a large office to maintain its own automatic switching exchange so that employees could dial internal numbers directly and have immediate access to external dial tone. AT&T responded to the increasing growth of computers in business with the Data-Phone, which made it possible for two computers to communicate over telephone lines.

In the late 1950's and early 1960's, AT&T slowly began to change the telephone number from an exchange name and number combination (for example, PYramid 9-2340) to All Number Calling (ANC). It took until the 1970's for ANC to become universal.

Technology (1945 to the 1960's)

The improvement in technology in the years following the World War II was explosive. The transistor, the key to modern electronics, was invented at Bell Labs in December 1947. Prior to the war, two young physicists named William Shockley and Walter Brattain began tinkering with the idea of adapting electronic techniques to telephone switching. Their initial work was interrupted by the war effort, but in late 1945 they were able to resume their experiments, this time with the help of another physicist, John Bardeen. For two years they worked on a semiconductor amplifier, and on November 17, 1947, the germanium crystal they were working with began amplifying a signal by forty times. The transistor effect had been discovered. Bell Labs demonstrated the transistor to the world on July 1, 1948, an event that radically changed the shape of the modern world. In 1956, Bardeen, Shockley and Brattain were awarded the Nobel Prize for their work .

The transistor revolutionized telephone switching systems in the late 1950's. Transistors replaced vacuum tubes in amplifiers, which allowed more phone calls to be carried on each wire, while also improving reliability. Then, in the 1960's, transistors made possible a new kind of telephone switch based on a computer technology called stored-program control; essentially, the switching system became a computer. The first electronic switching system (ESS) was placed in commercial service in 1965, and provided not only greater reliability but also made possible a wide range of customer services. By the end of 1967, there were ESS offices in eight states.

Before World War II, Bell Lab scientists had created a horn-reflector antenna to transmit microwave radio signals and had put together the basic elements of a microwave radio-telephone system that could handle 2,400 conversations over five channels. During the war, microwave technology came into its own as part of the crash program to develop radar. After the war, Bell Labs demonstrated its microwave system in New Jersey, and two years later the first experimental circuits were installed for domestic telephone use. By 1951, the two coasts were connected by a microwave system. Microwave radio was to become the dominant carrier for long-distance telephony in the United States.

Another result of the war was the heightened desire to stay in touch with Europe, so AT&T decided to readdress the need for a transatlantic cable. In June 1955, AT&T, along with the British Post Office and the Canadian Overseas Telecommunication Corporation, set out to lay the first long-distance submarine cable. The project consisted of two cables, each carrying messages in a opposite directions over the 2,000 nautical miles between Newfoundland and Scotland, at depths up to three miles. When finished, it would be able to carry 36 separate conversations at a time. On September 25, 1956, the transatlantic cable was opened to commercial service .

At home in the United States, coaxial cable continued to change the quality, amount and type of data that could be sent across the telephone network. Its unique ability to transmit television signals brought on increased demand. Coaxial cable eventually became the transmission media for the new cable TV market, bringing television programming into homes that could not be reached by traditional line-of-sight broadcasting. Although the telephone industry saw the value of coaxial cable, the typical local loop (the connection from the central office to the house or business) still consisted of twisted-pair wire, and the industry continued looking for ways to use this vast network for new services without replacing all of the twisted-pair wire. Little did industry insiders know that the growing cable television industry with its miles of coaxial cable would someday become a major competitor.

A revolutionary way of transmitting data was also being developed — digital transmission. The first digital transmission over regular cables was achieved by Bell Labs in 1956, and the first commercial digital system was installed in Chicago in 1962. Although able to carry more information, the maximum distance of these early digital transmissions was only about 50 miles. Several intercity digital transmission cables were installed as well as digital microwave systems, but the technology wasn't ready to take over the standard analog telephone system yet.

In November 1951, direct distance dialing was introduced to telephone subscribers. This allowed customers to dial calls to other cities without an operator's assistance. By 1956 over 11 million customers could dial nearby cities.

One last post-war technological development had to do with space. The use of communication satellites had been suggested in a science-fiction magazine by Arthur C. Clarke1397 as early as 1945. Bell Labs began to seriously consider the same idea a few years later. To test the theory, a passive satellite called Echo was launched in 1960. Echo was, in essence, a large balloon with a metallic surface that could reflect radio signals. The success of Echo prompted the launch of the first interactive communications satellite, Telstar, by AT&T in 1962. Telstar was able to carry several hundred telephone conversations. There was much debate in the United States government about whether AT&T should be allowed to control the telecommunications satellite and in September 1962 a compromise was reached resulting in the Communications Satellite Act. This legislation allowed the government to create a private corporation called Comsat that would be regulated by the government and owned half by private communications companies and half by private investors. In April 1965, Comsat orbited its own first satellite, called Early Bird.

The Beginning of the End (1960's to 1982)
During the late 1950's and early 1960's several companies began to make telephone-type equipment that was then illegally attached to Bell customers' lines. The Bell companies, when they found such attachments, would disconnect the attachments and sometimes threaten the customers with total disconnection of their service. The situation came to a head in 1968 when the Carter Electronics Corporation of Dallas, Texas, claimed that people should be allowed to use its product, the Carterfone, on their Bell lines. The Carterfone was designed to interconnect private two-way radios with the telephone system through a base station. In June 1968, the FCC decided the Carterfone could be connected to Bell lines without threat of disconnection. The Carterfone Decision effectively struck down existing interstate tariffs prohibiting attachment of customer-owned equipment to the public telephone system.

The FCC then pushed a little further and in 1969 decided that an independent company called Microwave Communications Inc. (MCI) could set up an intercity microwave relay system for private leased-line telephone use by businesses. Not only was this in direct competition with Bell System facilities, but the Bell System was also required to furnish MCI with connection to Bell System customers. In 1971, the FCC expanded the original MCI decision to allow any specialized common carrier to interconnect with the Bell local networks. MCI and others began skimming off some of the most profitable parts of the long-distance business.

But the battle didn't end there. In the years that followed, the FCC approved the use of non-Bell domestic satellites to provide private-line services, as well as the right for value-added carriers to resell AT&T long-distance service. In the 1977 Execunet decision, MCI won the right to offer switched long-distance services and compete head-on with AT&T in the long-distance market. With the 1980 Computer Inquiry II decision, the FCC drew a distinction between basic and enhanced services. Basic services would still be regulated; enhanced services (including customer premises equipment) would be deregulated and open to competitors. In addition, AT&T could only operate in the unregulated fields through separate subsidiaries.

In 1974, MCI and later the Department of Justice (DOJ) filed an antitrust suit against AT&T, charging that the Bell System illegally restricted competition and monopolized the marketplace. The lawsuit's stated goal was the breakup of the Bell System. United States vs. AT&T came to trial in March 1981 before U.S. District Judge Harold Greene. As the DOJ presented its case, it was clear that this was a battle AT&T couldn't win. AT&T began negotiations with the DOJ that resulted in a settlement called the Modified Final Judgment (MFJ) on January 8, 1982. The MFJ drastically changed the course of the telephone industry. AT&T was allowed to keep Western Electric, Bell Labs, and its long-distance business. It was also given the right to enter non-carrier lines of business, specifically the computer arena. The 22 Bell operating companies were recombined into seven independent regional Bell operating companies (RBOCs) known as Ameritech, Bell Atlantic, BellSouth, NYNEX, Pacific Telesis, Southwestern Bell Corporation (later to become SBC Communications), and US West. The RBOCs retained the regulated aspects of the business, which included everything except over-the-phone information services, telephone equipment manufacturing, and long-distance telephone service. AT&T was given two years to prepare for the breakup (generally known as divestiture), and on January 1, 1984, the old Bell System died.

Technology (1960's to 1982)
Although at first divestiture caused a great deal of public confusion, it finally sorted itself out, and the consumer began to see some of the technological innovations that resulted from the increased competition. These innovations included such things as automated telephone credit cards, expanded 800 services, pay-per-call 900 numbers, and new options for phone service ranging from call forwarding, voice mail, and caller ID to cellular mobile phones.

The first computerized switch, driven by huge software programs, began commercial service in 1976. It could handle 500,000 calls per hour and made possible a wide range of new services, including toll-free 800 numbers, custom calling features, and sophisticated call routing. And because it was controlled by a computer, the switching service was flexible and reprogrammable, which made for easier expansion. The future of telephone switching was here.

Slow but steady growth continued in digital transmission systems, but because of improvements in the use of the telephone company's analog systems, digital was not really pushed until the 1980's. By 1982 there were more than 130 million miles of digital transmission lines, and new players in the telephone market were extending the reach of digital transmission everyday.

A new transmission medium was also now on the scene — fiber optics. Fiber-optic cables use laser light traveling through glass, rather than electrons traveling through copper, to carry information. Because laser light can be modulated at very high rates, fiber-optic cable can transmit digital information at extremely high speeds. Corning Glass Works produced the first commercial fiber-optic cables in 1970. By 1980 there were 3,700 miles of fiber-optic cable installed in the United States, and the technology was constantly improving. Both the telephone companies and the cable companies began replacing copper cable with fiber-optic cable.

At the same time, growth in the satellite network continued. By the mid 1970's there were dozens of satellites carrying telephone and television signals around the world.

After the Breakup (1984 to the present)
With the breakup of the Bell System, the history of the telephone industry can no longer be tied to one company. It is now fragmented and scattered among any number of long-distance providers, equipment manufacturers, and local service companies. With AT&T's divestiture, parts of the telephone industry became a wide open field, and many companies went into the telephone business.

Originally, the first major players to enter the scene were the long-distance providers, primarily big companies like MCI and Sprint. But, by 1994 there were over 500 companies in the long-distance business, from those that built and owned networks to small companies that bought long-distance time from other providers and resold it to consumers. This increased competition has lowered long-distance rates while improving the quality of service. The competition will continue to be fierce as advanced data and voice services are developed.

Western Electric, now named AT&T Network Systems, remains the leading provider of central office and transmission equipment, but it is beginning to get serious competition from several other large companies.

The RBOCs, though still regulated, have maintained a strong, healthy status, and are pushing for deregulation that would allow them to enter more markets, particularly long-distance and video dial tone (cable television-like) services. They are in competition with one another, as well as with independent companies, like GTE, who are growing stronger. They are beginning to form alliances with other companies, both within and outside of the traditional telephone industry, to position themselves to step into new markets or expand old ones.

And there are new players on the horizon, big players who want a piece of the telephone pie — the cable television companies. Cable television lines run past more than 90% of the homes in the United States, and over 60% of the homes in America have cable service. Cable television lines are coaxial cables that are capable of handling voice and data transmissions as well as carrying cable television programming. The face of the telephone industry is in for a big change.

Technology (1984 to the present)
Because of changes that occur almost daily, it is difficult to give a comprehensive listing of the technology that has exploded over the last ten years: everything from enhanced custom calling features to sophisticated transmission lines for high-speed data and

interactive video. It is not far-fetched to envision a combination telephone, television, and computer terminal in most homes with video on demand, direct dialing to any country in the world, and on-line conversations. And this technology could be brought to you by a telephone company, a cable television company, a computer company, a microwave company, a satellite company, or any combination of the above. And it’s only just begun.

u contributed by Linda Stranahan

Telephones: How They Work

A telephone is a communication device that is designed to transmit speech to a distant point by means of electricity. There are four major parts to the telephone network: 1) the telephone instruments themselves; 2) the various transmission media used to carry the telephone signals; 3) the switching systems used to switch signals along the way; and 4) the devices used to control the operation of the network.

The telephone was invented by the American inventor Alexander Graham Bell in 1876 while he was working on improvements to the telegraph. Rival services using different telephone systems were set up, including one designed by the inventor Thomas Edison. At the beginning of the 20th century, telephones were standardized so that they could all be connected together. The telephones now in use are still remarkably similar to those original devices.

When sound waves reach human ears, they make the eardrums vibrate. Nerves in the eardrums change the vibrations into electric currents that travel to the brain, where the sounds are interpreted. Telephones work in much the same way.

To make a telephone call, the sound wave from the speaker's voice must first be converted into an electrical signal for transmission along a wire. The speaker talks into the mouthpiece, behind which is a transmitter. The sound waves from the speech generate vibrations in a thin circular diaphragm covering a chamber full of carbon granules. Electric current from the telephone wire flows into the carbon chamber, where the loose arrangement of the carbon granules acts as a variable electrical resistor. The amount of resistance depends on how firmly the granules are pressed together. The vibration of the diaphragm causes the electrical resistance of the carbon grains to vary, creating an electrical wave which closely resembles the original sound wave.

The earpiece of the telephone contains a receiver, which converts the electrical wave generated by the transmitter back into sound. Inside the earpiece is an electromagnet and a diaphragm. The varying electrical currents passing through the electromagnet cause the diaphragm to vibrate in the same wave pattern as the transmitter diaphragm. The vibrating diaphragm causes the air molecules to vibrate at the same rate, reproducing the original sound wave.

To operate, the telephone must be part of a complete electric circuit, which means it needs a power source, a conductor, and a switch. The power source is a 50V (volt) storage battery located in the telephone company central office. The conductor is the pair of wires that lead from the telephone to the central office. The switch is a pair of buttons on an older type telephone base or the single button on the handset of most modern telephones that moves when the user picks up the handset. Lifting the handset completes an electric circuit to produce a dial tone, which indicates to the user that the system is ready for a call to be made.

The rotary dial or key pad part of the telephone allows the caller to tell the switching system where the call should go. A dial works by sending a series of pulses or clicks to the switching network. When a “9” is dialed, for example, the current from the set is interrupted nine times so that the number dialed is converted into a pattern of interrupts. On a key pad, each button that is pushed produces a unique set of two tones — that is, signals of various frequencies. These act as coded signals that can be interpreted by electronic circuits in the switching network.

Routing the Calls

When a telephone number is dialed, the pulses or tones travel through the wires that connect the telephone set to a nearby telephone switching office (central office). These wires are called the local loop. Switching is simply the temporary connecting of circuits from the calling party (or device) to the called party (or device). Every North American telephone number has three parts: the area code that defines the part of the country, the three digit prefix that identifies the switching office, and the four digit number that identifies a particular telephone line in that switching office. When a local call is made, the first three numbers direct the signal to the specific switching office that handles calls for that area. The next four numbers direct the signal to the specific telephone line assigned that number. There can be 10,000 different phone numbers with the same prefix and area code. If the calling and receiving telephones are served by the same central office, all of the signal switching is done in that office. If the receiving telephone is served by a different central office, then the switching signals travel from the first central office to the second before the telephone that is being called can ring. For long distance calls, the signal goes from the calling telephone to the local central office, is routed to an interexchange office that sends it to another interexchange office for the area code being called, then is sent to the central office handling the called telephone number. Additional numbers are also used for dialing to other countries.

Each local telephone system is part of the Public Switched Telephone Network (PSTN). It consists of the equipment in the customer’s home or business, the equipment and services that the telephone company provides, and the wiring that connects the customer to the telephone company central office. Initially, callers could only be connected to others who were attached to the same exchange (central office). As telephone service grew, connections between exchanges became necessary and exchanges themselves became larger. A long-distance call had to be routed by three or four operators through various exchanges, resulting in slow, cumbersome and expensive service. As a result, automatic switching methods were developed that operate by dials or push-buttons on the telephone.

A telephone subscriber is usually connected by way of a local loop (two- or four-wire line) to a local telephone central office. Central offices are then interconnected through switching centers. The connections between centers are called trunks and may consist of twisted-pair copper wire, coaxial cable, fiber-optic cable or microwave-radio links. A typical incoming telephone call is routed at its central office into an appropriate outgoing trunk. Today, computers choose between various alternative routes to send the call most efficiently. High-capacity routes are provided between any two central offices that carry a lot of traffic. In addition, a technology called multiplexing allows several telephone calls, data transmissions and/or video to be sent over the same wire at the same time.

Analog Versus Digital Signals

Originally, analog transmissions were carried by all of the lines in the telephone systems. An analog transmission contains a continuously variable signal (much like a sound wave) as opposed to a discrete signal (such as digital computer data). But the constantly varying analog wave forms can become distorted, and all transmissions carried over long distances lose strength and become noisy (gain interference) as they travel. Some of this noise comes from switching circuits and amplifiers; some is encountered as crosstalk, or signals that cross between wires; some is from radio signals creating analog currents in the telephone wires. To maintain correct signal strength, the signals must be amplified periodically, and analog amplifiers not only amplify the voice and data signals but also increase the noise. Analog transmission is sufficient for most voice transmissions because a small distortion in the signal and some additional noise will not normally be detected by a listener. But analog switching and transmission systems are difficult to maintain and costly. In addition, accurate transmission is absolutely essential for data transmissions, so with that need and a need for improved switching and transmission, came digital communication systems.

In digital communication systems, analog signals are converted to a digital form, a process called analog-to-digital or A/D conversion. To do this efficiently the voice signal itself must be converted to a digital form, so that the electrical wave form no longer looks like the sound wave, but is a series of pulses. The amplitude or strength of the original wave form is sampled at regular intervals (for voice messages, usually 8,000 times a second), then the value of these samples is converted to a binary code. A binary signal consists of two states only, a zero or a one. These are used in much the same way as dots and dashes in a telegraph to create various symbols and signals. Practically all voice, picture, instrumentation and other data can be coded in binary form. This is referred to as modulation, a process whereby original information is translated and transferred from one medium to another. The technique of sampling an analog signal or voice and converting it to binary code is called pulse code modulation, or PCM.

There are several methods to transmit digital binary signals. Once a particular pair of representative signals has been selected, the transmission of one or the other is determined by the binary state (that is, one or zero) that is to be communicated. In an example of its simplest form, a modulator transmits a burst of specific radio frequency when a “one” appears and nothing when the “zero” appears, not unlike Morse Code transmissions on a telegraph. Other forms of coding used for binary signaling include frequency-shift keying and phase-shift keying. In frequency-shift keying, a binary one or zero causes the frequency to shift to either one of two predetermined frequencies. In phase-shift keying, the sign, or polarity, of a high-frequency carrier shifts between positive and negative when the binary input shifts from zero to one.

Digital transmission uses regenerators/repeaters rather than amplifiers to maintain signal strength. When the distorted and weakened signal reaches the regenerator/repeater, the repeater determines, as best it can, the original sequence of zeros and ones, then regenerates the original signal and forwards it in its original, or near original, format. In this way, digital signals can travel great distances, be combined with other digital signals, and be regenerated and decoded without degrading the information. In addition, only a digital network can handle high-speed data and graphics/video transmissions as well as voice calls.

Switches and Switching

There are several types of central office switches currently in use. The oldest, but now nearly completely replaced, is the electro-mechanical crossbar switch. In this switch, a layer of current-carrying bars is arranged horizontally and is separated by a few thousandths of an inch from a similar layer arranged vertically. Electromagnets that are triggered by the dialed impulses cause the appropriate bar to move, creating a circuit between the incoming and outgoing connections. The round telephone dial was deliberately designed to require a moment's wait after each digit was dialed to give the switches time to make the necessary connections. A second, somewhat more common type of switch is the analog electronic-switching system (ESS), which has no moving parts. ESS is a complex electronic-switching network in which the actual connections are established by transistors whose resistance can be changed by the impulses received. Since a delay was no longer needed for the equipment to make the connection, push-button telephones could be used.

The most modern type of switching device is the digital stored-program switch. Incoming signals from a telephone set are first converted into digital patterns of ones and zeros or on-and-off electric pulses. On the basis of the incoming pulses, the digital-switching circuitry, controlled by a computer, finds the shortest and least loaded route to connect the incoming call to the outgoing line. Because the routing is controlled by a computer program, telephone line additions and drops can be changed fairly easily. Making changes in analog switches, on the other hand, usually requires actual physical rewiring.

Copper Wire Versus Fiber Optics

In the original telephone networks, copper wire was the most popular transmission medium. The most common use of copper wire was as a twisted-pair configuration, which consists of strands of insulated copper wire twisted together in pairs to form a cable. Although telephone lines were primarily designed to transmit voice signals, the advent of the modem (modulator/demodulator) made it possible to connect telephone lines to computers and use the lines to transmit binary data. Having telephone lines in place that could be used for data transmission was an important factor that helped start the telecommunications revolution. As requirements for the speed of data transmission increased and distances became greater, transmission on twisted-pair wire became unacceptable. Its relative slowness and susceptibility to electrical interference, which can garble data, made it undesirable for high-speed data transmission. Although still used throughout the telephone networks, twisted-pair wire is now found primarily in the local loop from individual homes and businesses to the central office.

Coaxial cable, which consists of a copper wire surrounded by at least one and sometimes several layers of insulation, can transmit a larger amount of data at faster speeds than twisted-pair wire (up to 2 gigabits per second compared to about 2 to 10 megabits per second for twisted-pair wire) and does not suffer from electrical interference. Coaxial cable has long been used by cable television operators and is now being installed in neighborhoods by many telephone companies because of its ability to carry video, voice and data signals over the same line. The primary disadvantage of coaxial cable is its size; the coaxial construction and layers of insulation make the cable thick, expensive and harder to install.

Fiber-optic transmission systems (FOTS) were introduced to North America in the late 1970's, and many telephone companies are now replacing much of their high-capacity wire cable with fiber-optic systems. The main components of FOTS are optoelectronic terminals and fiber-optic cable. Fiber-optic cables are created by binding together 1 to 100 or more strands of smooth, clear glass fibers that are as thin as a human hair. A single cable of 96 fibers is less than an inch in diameter, yet it can support millions of voice channels. The optoelectronic terminals have two components: receivers and transmitters. Transmitters convert incoming voice, data and video signals into pulses of light emitted by a laser device about the size of a pinhead and send them over the fiber-optic cable. At the other end, photodetector receivers convert the pulses of light back into electrical signals that can be recognized by the voice, data or video terminal. In addition, repeater stations are only required every 25 to 50 or more miles.

Fiber-optic technology represents the wave of the future in telecommunications transmission media. Theoretically, just one fiber-optic strand could carry hundreds of millions of telephone conversations — thousands of times more than a single satellite. Although such theoretical limits are beyond our current technological capabilities, many fiber-optic links are already carrying tens of thousands of telephone circuits. This capacity is comparable to satellite or microwave systems. Laboratory systems are doing hundreds of times better than that. A benefit of fiber-optic transmission is that as the technology improves, only the transmitting and receiving ends of a fiber-optic system will need to be replaced. The existing fiber-optic cable, the major expense in developing and installing a fiber-optic system, is already able to carry a greatly expanded number of calls. In addition to its current ability to carry more data at faster speeds, fiber-optic cable is smaller, lighter and more durable than wire-based media, and is unaffected by magnetic or electrical fields. It is particularly suitable for transmission of the large amounts of data needed to create complicated graphics, photographs and full motion video. The telephone industry, large cable companies and others have already laid many miles of fiber-optic cable (the nation's long-distance lines are already overwhelmingly fiber optic).

Radio Transmission

Telephone signals also travel by radio waves between switching systems and in wireless and cellular operations. Older mobile telephones, generally located in cars and trucks, allowed someone to tie into the central network from a moving vehicle. Initially, such telephones were connected to the public switched telephone network by a central radio transmitter and receiver, each telephone being equipped with radio transceivers. This simple system allowed only a few hundred subscribers in a city.

A newer system, introduced in the 1980's, is called cellular mobile telephone. In this system a city is divided into a series of cells, each equipped with a central transmitter-receiver base station. The cells are arranged so that the set of frequencies (one for transmitting and one for receiving) used in adjacent cells are different, although the same several frequencies are reused throughout the system. As a car moves from one cell to the next, the radio telephone automatically switches (or "hands-off") from one set of frequencies to another, thus allowing a continuous telephone conversation. Calls from these phones travel by radio to the nearest cellular radio tower and base station, then by wire or microwave to a nearby telephone switching office. If, for example, the person in the car is calling a home or a business telephone, the call continues over wires to the number being called. If the caller wants to talk with someone with another cellular telephone, the call is sent by radio to the base station and cellular tower nearest to the telephone making the call, is then sent by wire or microwave to the tower nearest the telephone being called, is next radioed to the telephone being called, and is finally picked up by the antenna on the called cellular telephone. A continuous signal from a cellular phone tells the system where that phone is at all times so that it can be found in order to receive calls.

Today's cellular systems are designed to allow far more users than the old mobile telephone system. However, there are some problems remaining with such systems, such as security issues, high cost of service and limited geographical coverage. In many cities, a large number of users may be concentrated in a small section of town (for example, the Wall Street area of New York City). This can overload a given cell. Cells can be subdivided but they cannot be arbitrarily broken up into smaller units to handle an over concentration, because if the cells are too small, signals from other cells often begin to interfere.

Other kinds of wireless radio systems can also be used to serve the telephone and data transmission needs in a small stationary area, such as an office building.

Microwave radio systems, another form of radio transmission, are used in a variety of communication systems, but are primarily associated with high-speed transmission of signals over long distances. A microwave system consists of a network of transmitters and receivers that are in "line-of-sight" of each other. When necessary, amplifiers are used to boost the signal strength.

In a microwave system, telephone signals are used to modulate high-frequency radio signals known as microwaves. These radio signals are transmitted from antennas located on tall buildings or towers to other antennas that are within sight of each other. Since microwaves have frequencies up to several billion Hertz, or cycles per second, large numbers of telephone conversations can be carried on each microwave frequency band.

Because of the great carrying capacity of microwave systems, they quickly replaced much of the early wire systems for carrying long distance telephone calls. However, since microwave signals tend to travel in straight lines, the relays must be in sight of each other. For transmissions over great distance, many relays must be used, and, of course, such relays cannot be used to span the oceans between continents.

Satellite Transmissions
For long distances, and especially for transcontinental transmissions, telecommunications companies throughout the world turned to satellite relays using communication satellites. These satellites are located in geosynchronous Earth orbit (GEO) some 22,350 miles (35,700 kilometers) above the surface of the Earth. At this altitude, a satellite in a circular orbit moves around the Earth once every 24 hours. Thus a satellite over the equator will appear to hang suspended in one place relative to the Earth. Satellites in geosynchronous orbit can serve as relay stations without the interruptions that would occur if they were in lower orbits and passed out of range several times a day.

In satellite communications, telephone signals travel through the normal telephone network to a satellite ground station. There, the signals are modulated as radio frequency signals and are beamed into space from huge dish antennas. These dishes have the shape of a parabola to send out a narrow beam. Up in space, a communications satellite receives the radio signals and acts as a repeater to boost and retransmit the signals to a region of the Earth. A receiving Earth station within this region then picks up the signals, amplifies them, and feeds them back into the normal telephone network in a different part of the country or world.

Today, some countries still depend upon satellite communication for international telephone calls, and many of these calls are handled by communication satellites belonging to INTELSAT (International Telecommunications Satellite Organization). The United States, however, primarily uses undersea fiber-optic cables for international calls.

Summary
The modern telephone has developed from a simple instrument that transferred sound a few hundred feet to a complex network that connects the world. It revolutionized how we communicate and led the way for the telecommunication explosion that followed.

u contributed by Linda Stranahan

Telephone Industry

After a long history of slow, steady growth, the once stable telephone industry is now in a state of flux. New services, new equipment, new technologies and new companies are making big changes in the way telephone companies are doing business. What was once a huge, regulated monopoly is now a group of multi-service telecommunications providers eager to compete using the latest technologies.

Until the 1980's, most of the telephone service in the United States was provided by American Telephone and Telegraph (AT&T). AT&T was a regulated monopoly that ensured universal service (telephone service available to all homes and businesses), kept the price of local calls to a minimum, and carried the majority of long-distance calls through an extensive long-distance network.

Following a series of antitrust suits brought by the Federal government against AT&T, the resulting 1982 Modified Final Judgment (MFJ) split off the long-distance portion of the Bell system (AT&T) and recombined the 22 Bell operating companies into seven regional Bell operating companies (RBOCs) — Ameritech, Bell Atlantic, BellSouth, NYNEX, Pacific Telesis, Southwestern Bell Corporation (now SBC Communications) and U S WEST . The original terms of the agreement prohibited AT&T from offering local telephone services and prohibited the RBOCs from manufacturing telecommunications equipment, providing long-distance telecommunications services beyond certain boundaries, or offering information services and video entertainment. It also opened the door for other non-Bell companies to enter the long-distance market.

AT&T was immediately thrown into a competitive market for long-distance service. Now, AT&T is only one (although still the largest) of nearly 500 long-distance providers, with MCI and Sprint the most notable among them.

The RBOCs (or Baby Bells, as they are sometimes called) have maintained their regulated monopoly standing for local service for several years, but pressure is building for competition in this market also. With the start-up of new businesses and the expansion of technology, the make-up of the telephone industry is changing. The industry's major players are still primarily telephone companies, from local access to long-distance to wireless, but that may change over the next five years. Currently, the types of companies involved include:

u Local Exchange Carriers (LECs), which make connections for calls originating and terminating within a certain geographical area. LECs provide services in two categories: local exchange services and exchange access services to the long-distance providers. The most notable of these are the seven RBOCs, but there are also some independent companies, like GTE, that provide local phone service, and the number of independents is growing.
u Interexchange Carriers (IXCs, sometimes abbreviated as IECs) are the long-distance providers that take calls originating from the LECs and transport them for connection outside the local area.
u Competitive Access Providers (CAPs) moved into many of the larger cities in the United States in the late 1980's to try to capture some of the long-distance access dollars of large businesses. By laying state-of-the-art fiber-optic cable and offering expanded

services, bypass companies, such as Teleport Communications and Metropolitan Fiber System (MFS), were able to win some of the LECs' most attractive customers.

u The cable television (CATV) companies, with their networks of coaxial and fiber-optic cable going to over 60 percent of the residences in the United States, are positioned to become major players in the local exchange market. New telephones that work off of coaxial cable and wireless sets using antennas mounted onto the cable strand are providing them with the technologies needed to make telephone access cost-effective. The ability to group video, voice telephony and data services into one marketable bundle gives the cable companies powerful leverage when approaching the residential marketplace. In addition, coaxial and fiber-optic cable can already handle the frequencies necessary for voice communication, so it will be cheaper for cable companies to add voice than for telephone companies to add video to their existing networks. However, cable companies need to build networks into business areas if they want to address the business market.

In the past, traditional cellular and mobile radio services have been interconnected with the wired local-exchange networks, providing mobile service to customers who were also connected to the network at a fixed location, such as a home or business. The newly emerging range of wireless access providers, both cellular and personal communications services (PCSs), provides telephone services that can follow subscribers around a building, neighborhood, country or continent; a powerful alternative to wired lines into a business or home. Such strategies are attractive to new telecommunications companies as well as to cable companies who can use wireless access to move subscribers onto their existing networks.

The Telephone Market

In the past, plain old telephone service (POTS) generated little marketing activity since the local telephone company, as the sole provider of dial tone, faced little or no competition. However, the flood of new entrants now moving into the local market is likely to change the marketing picture substantially.

In addition to competition for local calling, the RBOCs face a sharp reduction in one of their biggest money makers: the local access fees they collect from long-distance carriers. Those fees totaled $30.8 billion in 1994, some 30 percent of the RBOCs' total revenue and more than 40 percent of the long-distance carriers' expenses. The RBOCs would like to get into long-distance, but long-distance carriers also expect to get into local service — in part to slash access fees.

The long-distance market is already characterized by competition, fierce advertising and targeted marketing techniques among AT&T, MCI, Sprint and others. But not only do the long-distance companies want to stop paying the high access rates being charged by the LECs, they are also anxious to get into the local access market. They've already made inroads into the more lucrative large businesses by bypassing the LECs for individual companies that are high-volume long-distance users.

Pricing will almost certainly be a key strategy for the future. Providers may combine and market POTS services with advanced features, long-distance service or with non-telephony services, such as home shopping or traditional video services. By creating value-added portfolios of services, they will try to lure customers away from established providers. Since many of the new entrants may not be regulated, pricing is almost certain to be used as a competitive tool. In short, marketing efforts are likely to increase substantially over the next few years.

Mergers and Strategic Alliances

As markets expand and new companies emerge to provide service, the make-up of the telephone companies is changing. The toll providers and the RBOCs are expanding their focus and getting into new aspects of the business. Some of this is being accomplished through mergers and strategic alliances, sometimes between companies who were previously enemies or at least competitors. Examples of some of these alliances are:

1) Sprint has formed an alliance with CATV operators Tele-communications Inc. (TCI), Cox Enterprises and Comcast to build and operate a nationwide wireless telephone network.
2) U S WEST has bought 25 percent of Time Warner and is launching video on demand trials. Time Warner already offers bypass services in 15 cities and has applied to offer residential service across New York and Ohio.
3) Pacific Telesis, Bell Atlantic and NYNEX have formed a joint venture with Hollywood-based Creative Artists Agency to develop new multimedia programming. Ameritech, BellSouth and SBC Communications have joined with Walt Disney for the same purpose.
4) NYNEX has invested $12 billion in the Viacom cable systems, while SBC Communications has purchased the Hauser Communications cable system in Maryland.
5) AT&T spent $12.7 billion to purchase McCaw Cellular and has bought a string of technology start-up companies, including game makers 3DO and Spectrum Holobyte and software publisher Knowledge Adventure. AT&T is also one of the big backers of General Magic Inc., which provides the software for its new PersonaLink messaging system.
6) Bell Atlantic and NYNEX combined their cellular companies, while U S WEST formed a pact with AirTouch, the cellular business spun off from Pacific Telesis.

Worldwide, mergers and deals among communications, information and entertainment companies hit a record $27.8 billion in 1994. With all of these moves, countermoves, alliances and mergers, where do the telephone companies stand financially?

In late 1994, Moody's Investors Services issued a report predicting that the average annual revenue growth rate for the telephone companies will decrease from the 2 percent they generated from 1988 to 1993 to 1.4 percent for 1994 to 1998. Accordingly, over the next three to five years, Moody's predicts that the average credit rating of local telephone companies will drop one notch from Aa3 to A1. However, Moody's doesn't believe that the telephone companies face an immediate threat from wireless, the cable companies or the information superhighway. These analysts believe the major competition will come from inside the telephone industry. Moody's also believes that the telephone industry is well positioned for strong financial performance. Even though the business risks for the RBOCs will increase, their ability to generate cash flow isn't going to be affected.

Government Issues

One of the biggest issues still to be resolved in the expanding telephone industry is regulation. There is virtual agreement in the telecommunications industry, on Capitol Hill and in the state governments that deregulating local service will be good for the country. The RBOCs are applying pressure to replace the vintage 1934 regulations. But partisan infighting between the Republicans and Democrats has prevented action in the past and may still slow things down.

Even so, between June and October of 1994, the RBOCs sued for the right to enter the long-distance business; the House of Representatives voted for the first major revision of communications law in 60 years; regulators told a phone company it could offer cable TV on its home turf; a cable TV company signed a deal to offer local phone service; and the government completed its first-ever auction of the public airwaves, taking in twice as much money as expected. This auction of radio frequencies by the government will revolutionize the industry by substantially increasing the wireless call-carrying capacity, more than tripling what is currently available. This new capacity will allow cellular operators to offer a broad range of services that promise to make mobile communications even easier.

For the RBOCs, the legislature and the judiciary seem to be moving in slow motion, while the RBOCs continue to lose local business and are prevented from entering the lucrative long-distance and cable markets. Consequently, in July 1994 four Baby Bells (Bell Atlantic, NYNEX, BellSouth and SBC Communications) asked Judge Harold Greene, who continues to supervise the consent decree that broke up the Bell system, to set aside the ruling and declare that his services are no longer necessary. It may take years to resolve this monumental case.

In conjunction with the deregulation issues, the Clinton administration insists on universal access to avoid the creation of a class of information have-nots and to provide access for the public schools.

With so many companies jumping into the telephone industry, a concern that arose with the original telephone systems has again surfaced: how to make sure that everything will work together. A new group called Wiring America has started an initiative to standardize the in-home wiring that will be required to support all of the new services. A task force that includes Tele-Communications Inc., AT&T Wiring System, SMART HOUSE, the CEBus Industry Council and others will work to establish minimum guidelines for future residential wiring requirements and increase awareness of these guidelines to consumers and builders. In the beginning, the group will concentrate its efforts on new home construction and remodeling.

Technology and the Future

The driving force behind today's telephone frenzy is technology, the most striking examples of which are fiber-optic cable and wireless systems. A single glass strand of a fiber-optic cable can carry at least 32,000 simultaneous conversations . Laboratory experiments have resulted in 10 times that many. Continuous improvements in both wired and wireless technologies promise a steep and steady decline in the cost of communications, similar to the way microprocessors drove down the cost of computers and sparked the personal computer (PC) revolution.

One of the major technological problems faced by the telephone companies concerns bandwidth. Bandwidth refers to the range of radio frequencies a cable or wire can carry. The amount of bandwidth a cable or wire is capable of handling determines what kinds of communications it can carry. A wide-band circuit, for example, can carry a TV channel and is also capable of providing 1,200 telephone voice channels. The twisted-pair wire of the telephone companies is considered low- or narrow-bandwidth and was designed originally to carry analog voice signals only. The RBOCs are attempting to protect their investment in twisted-pair by utilizing compression technologies to maximize the limited bandwidth. But compression technology doesn't work on analog systems  .

So, for years the telephone companies have been upgrading and expanding their services by changing to digital signals. In a digital network, the information is encoded as a series of ones and zeroes rather than the continuously varying wave of an analog network. Modern digital switches make available a broad range of revenue-generating advanced services that range from traditional custom calling features, such as Call Forwarding and Call Waiting, to sophisticated screening features and personal mobility services. Traditionally, these advanced features have been the services most aggressively marketed by local telephone companies. New features are relatively inexpensive to add to the digital switches (generally requiring only software additions), and each feature can add $3 to $6 in revenue per line. Digital networks also have several major pluses over analog ones. First, they're cleaner; they have far less noise, static, etc. Second, they're simpler to monitor because they can be measured more easily. Third, because digital signals can be compressed, digital transmission can be more efficient than analog transmission.

But most of the telephone companies' local loops (the connection from the telephone network to the home or business) are still analog twisted-pair wires. So the telephone companies still need to extend the digitalization of the telephone system to the business or the home. They're doing this through a program called Integrated Services Digital Network (ISDN). ISDN is a fully digital telephone system that converts voice signals to digital signals right at the telephone. Although the technology has been around for some time, it took the impetus of full-blown competition to get the LECs to give it their full attention.

About half of the telephones in the United States had access to ISDN in 1994. In many areas, ISDN may be accompanied by the rewiring of the telephone system with fiber-optic cable. The main trunks of most of the telephone systems were rewired with fiber-optic in the 1980's, and in the early 1990's plans were made to replace the entire system of copper wire with fiber-optic cable. But this is an investment-intensive solution for the telephone companies. It's estimated that to connect every residence and business in the United States to a fiber-optic network would cost more than $100 billion. Estimates for the entire rewired system range up to $325 billion. It was originally thought that much of ISDN would require optical fiber. But rapid improvements in data compression technology, based on ever faster, ever cheaper computer processing power, means that it may be possible to use the existing copper wire to send much more data than anyone ever imagined.

Meanwhile, the cable television companies, with their existing networks of coaxial and fiber-optic cable, provide an ideal medium for a communication highway that can handle multiple types of media. And the cable companies are learning how to access and manage their facilities with an eye towards telephone service.

Advanced Network Services

Along with the technological advances in networks, the various telephone companies have developed advanced services and equipment such as the following:

1) AT&T engineers have devised a gadget to turn a television into a combination answering machine, home banking terminal and interactive shopping terminal.
2) GTE Corporation has a cordless phone that turns into a cellular phone when it leaves the house.
3) BellSouth is pushing personal digital assistants (PDAs) that send and receive E-mail, faxes and voice calls wirelessly.
4) Both AT&T and MCI have expanded their original toll-free services. AT&T's Advanced 800 Services include time of day and area code routing, single number 800 service (for both interstate and intrastate), automatic number identification and other options. MCI's Enhanced 800 Services include time of day and day of week routing.

Virtual private networks (VPNs) eliminate or partly eliminate the need for fixed point-to-point private lines by providing on-demand dial-up circuits through the public switched network. Instead of being charged for several private lines, customers can be charged for the time they use on a group of shared private lines. Virtual private network lines are in use only while information is being transferred. Virtual private networks can serve multiple locations that can be accessed through the use of customized dialing plans.

Mobile locator services are currently being tested in major U.S. cities. Mobile locators allow motorists to call for roadside assistance without leaving their vehicles. They can also be used to help authorities track a stolen vehicle or fleet service operators keep track of their vehicles and personnel. The service requires multiple antenna towers throughout the coverage area, towers that are tied to a network center and transceivers in customers' vehicles.

Basic cellular service is also changing. Digital cellular is state-of-the-art cellular communications and increases the capacity of analog cellular (the current standard for cellular communications) up to 15 times. In addition, digital virtually eliminates three major problems encountered by users of analog cellular: static, loss/interruption of signal when passing between cells (during hand-off) and failure to get a connection because of congested relays.

Personal Communications Services (PCSs), using higher frequencies and smaller cells than telephone company cellular services, provide low-cost portable telephones for use around a town or building — a possible rival to the wired local telephones. Some of the services include: personal numbers assigned to individuals rather than telephones, call completion regardless of location, billing either to the caller or to the PCS customer, and call management services that give the called party much greater control over incoming calls.

Even the new multimedia products and services are playing a role in the new telephony marketplace. Multimedia technology refers to the combination of multiple forms of media in the communication of information. Technologies that were once analog — video, audio, telephony — are now digital. The power of multimedia is the integration of these digital technologies. Multimedia technology will ultimately take the differing technologies of the computer, the telephone, the fax machine, the CD player and the video camera and combine them into one powerful communication center.

Video dial tone, for the telephone companies, means that the telephone line provides video to homes and businesses. More than that, the telephone companies intend to provide digital-quality service and access to video libraries, which will include entertainment, near video on demand and certain interactive software packages.

Video conferencing, also known as video teleconferencing, allows the caller to communicate with others using video and audio software and hardware to see and hear the other party. Audio can be provided through specialized video conferencing equipment, through the telephone or through the computer. The video has traditionally been done with dedicated video equipment, but increasingly, personal computers communicating over switched digital lines are used.

The convergence of all of these new technologies is known as the information superhighway. There are several major players creating the information superhighway, most notably the telephone companies, cable companies and computer companies. But mergers, partnerships and joint ventures are continuing at an amazing pace. Each of the players faces a unique set of challenges. The telephone companies need to provide higher bandwidth in order to deliver services that feature data and video. The cable companies already deliver adequate bandwidth to homes, but they have yet to figure out how to expand beyond entertainment video into other information services, with all that implies in terms of infrastructure and support systems. And the computer industry, through its hardware, software and millions of users, creates a means and a need for the information superhighway. Currently, the Internet, often using standard telephone lines, gives us an idea of what a limited information highway looks like. With the transmission of broad-band frequencies to carry video and high-speed data and allow interactivity, it will become a superhighway. What all this means to the structure of the telephone industry remains to be seen, but it seems certain that the industry will look quite different in the next five to ten years.

u contributed by Linda Stranahan

Telstar I and II

The Telstar satellites were the first man-made satellites sent into space for the express purpose of providing experimental, real-time television broadcast transmissions. Telstar I and II were owned and operated by American Telephone and Telegraph (AT&T), built by Bell Laboratories and launched by the National Aeronautics and Space Administration (NASA) in 1962 and 1963.

The Eisenhower administration, attempting to balance industry and U.S. military objectives regarding space exploration and telecommunications, organized NASA in 1958. NASA's job was to guide space exploration in the direction of peaceful purposes that benefited all people. As part of its effort, NASA provided the launch facilities for a variety of satellites. During its first decade, NASA's duties seemed to alternate between "man in space" duties and commercial satellite deployment. In the years prior to Telstar, *passive* satellites, those that reflect radio waves, had successfully been deployed. Telstar I was the first *active* satellite sent into space. Active satellites receive, amplify and transmit signals back to a general geographic area, called a footprint.

Satellites transmit along a line of sight. This means that if a receptor or earth station can "see" the satellite, it can pick up the signal. Telstar I was launched on July 10, 1962, in a low- to medium-altitude, elliptical orbit and could only relay transmissions between two earth stations for a short period during its revolution around the Earth. Telstar I circled the Earth every 158 minutes. Due to its limited line of sight, Telstar I was able to transmit for only about 20 minutes of that time. Telstar I's elliptical orbit ranged from 600 miles to 3800 miles above the Earth's surface with the orbit apogee, or farthest distance, strategically placed for maximum transmission to its earth stations.

The first picture Telstar I transmitted was that of an American flag posted outside the transmitting station in Maine. Telstar's capacity to transmit signals was limited to a single television broadcast feed as well as to several telephone circuits. The satellite also provided computer-to-computer transmission for data, facsimiles and so on. And it provided the first, small glimpse of the future of satellites and their capabilities. Unfortunately, just seven months after its launch, Telstar I suffered radiation damage from a 1962 high-altitude atomic bomb explosion and was unable to operate any longer.

Telstar II was launched on May 7, 1963. It looked like Telstar I but was able to withstand the effects of radiation. Telstar II circled the Earth every 225 minutes, and on its tenth trip around the globe, it carried the first color-television broadcast over the Atlantic Ocean. Two years after its launch, becoming less effective than the newer satellites, Telstar II was turned off.

Even though neither satellite was used for a long period of time, they both provided invaluable information. Besides performing the then-incredible task of broadcasting via satellite, they carried devices that tested the effect of natural radiation on satellites. These small (34.5 inches), but heavy (170 pounds), round aluminum satellites gave the telecommunications industry and space exploration scientists knowledge that allowed for future leaps in technology.

Within a week of Telstar I's launch, President John F. Kennedy proposed what would become the Communications Satellite Corporation (COMSAT) to oversee the United States' interests in satellite communications systems. Private companies, such as AT&T, were invited to invest in order to further the development of COMSAT. Although a positive step, the establishment of COMSAT meant that independent and limited-use satellites, such as Telstar, would soon be unfeasible.

The problem with low- and medium-orbit satellites, such as Telstar, was that they were so close to the Earth that they had to travel very fast, 17,500 miles per hour, to prevent being pulled into the planet by gravitational force. The speed allowed for a rather short transmission time. As Telstar I and II were orbiting the Earth, the first geostationary satellites were being tested. Geostationary satellites, traveling at 6,879 miles per hour, are placed in a high-altitude orbit of 22,300 miles above the Earth's equator. Due to their distance and position, these satellites seem to travel at the same speed as the Earth and appear to be stationary over a single spot. Since they then "see" a given footprint or transmission area on a continuous basis, they can transmit to that geographic footprint continuously, which results in much more effective use.

The 1950's and 1960's were an exciting time of unlimited possibilities with regard to space and satellites. Earth-bound scientists and musicians alike were enamored with the future of space exploration. In fact, a report about the Telstar satellites would not be complete without reference to the popular song they inspired. In 1962, the Tornadoes sent their *Telstar* as high as it could go — to number one on the *Billboard* music chart.

The newer, more powerful satellites launched into geostationary orbits brought an end to the limited Telstar satellites. But the future of the space and telecommunications industries owes everything to satellites like Telstar I and II.

u contributed by Michele Messenger

Telephone Trends

Since the breakup of the Bell system in 1984, the telephone industry has gone through a metamorphosis. Sometimes the change has been easy, but most of the time it's been difficult, complex, and even painful.

The year 1994 was a particularly eventful year during which the following happened: 1) the regional Bell operating companies (RBOCs) , restricted by law to providing local phone service, sued for the right to enter the long-distance business; 2) the U.S. House of Representatives voted for the first major revision of communications law since 1934; 3) regulators allowed a phone company to offer video service, an activity that had previously been prohibited; 4) the government auctioned off public airwaves for the first time ever; and 5) mergers and alliances were announced (and sometimes died quickly) between RBOCs, between RBOCs and cable television companies, between long-distance carriers and cable television companies, and between cellular companies and almost everybody…and it's not over yet. The next five years will see huge changes in who provides telephone service, how it is provided, what can be done with it, and who will oversee the industry. Here are some of the major trends in the telephone industry.

Telecommunication Players

It used to be when the telephone industry was mentioned, the only companies involved were the long-distance carriers (like AT&T and MCI) and the local service providers (the RBOCs and a few independent phone companies like GTE). Now, all kinds of companies are offering, or want to offer, telephone service.

Telephone Companies

With the 1984 divestiture of the Bell System, AT&T retained the long-distance and equipment portions of its telephone business, while the RBOCs kept all the local service as regulated monopolies. Long-distance became a fully competitive field, with the result that over 300 interexchange carriers (IXCs) currently provide long distance service in one form or another.

About one third of the RBOCs' profits come from the "access charges" that long-distance companies must pay for relaying calls to local customers. Another hefty chunk of the RBOCs' revenues comes from toll calls that occur within the RBOC calling area. While the long-distance companies want to get into the local exchange business to stop paying these huge access fees, the RBOCs feel they need to offset any loss in access fees by getting into the lucrative long-distance field. Pressure is mounting from both sides to get into the other's business.

Added to this mix are the independent phone companies. Since divestiture, these companies have been growing in strength and size. Some, like GTE, have become formidable, rivaling the RBOCs in number of customers, services offered, and plans for the future. Others have joined forces in consortiums and professional groups to make sure their voices are heard. Obviously, they are in favor of a more open telephone industry.

Cable Companies

Faced with what has been a hostile regulatory climate for their industry as well as somewhat slowing growth rates, cable television companies are increasingly interested in telephony as another lucrative revenue stream  . Analysts estimate that the cable companies would only need to provide phone service to 15 percent of the homes in their area to make a profit. With their extensive fiber-optic and coaxial cable networks, cable companies have the potential to provide voice, video and data services at any level required by their customers.

Two items challenge cable entry into the telephone market, though. First, many experts believe the cable companies have grossly underestimated the time, cost and complexity of integrating a phone system into a cable system. Cable companies will have to spend billions of dollars to upgrade their one-way video transmission systems to two-way communications systems, as well as learn how to operate them. Second, although cable companies are working to improve their customer service performance, they will have to become extraordinarily proficient in this area before the public will rely on them for an essential service like telephone access. Insiders predict that cable operators probably will overcome these challenges and be ready to offer large-scale telephone service sometime in the late 1990's.

Competitive Access Providers (CAPs)

Competitive access providers (CAPs) have moved into some of the bigger cities and laid state-of-the-art fiber-optic cables to tempt large businesses away from the local telephone companies. They offer access to the long-distance carriers and services that only fiber networks can handle. CAPs have seen a great deal of success since the 1980's and are now poised to move into other areas of the local telephone business. They are pursuing these interests through the courts and by striking alliances with cable television and long-distance companies. They are currently positioning themselves to be local service and long-distance access providers when the telephone industry is deregulated.

Wireless Companies

In the past, traditional cellular and mobile radio services worked in conjunction with the wired networks to provide local service. In the last ten years, cellular phones have gone from relative obscurity to common items. Personal communications services (PCSs), using high-frequency wireless technology, are positioned to take the wireless portion of the telephone industry into new areas. Wireless services are or will be in direct competition with purveyors of many aspects of telephone service.

Utility Companies

Telephone and/or cable service could start being delivered in whole or in part by some very unexpected sources. Look at these examples:

1) New York State Thruway Authority is exploring the feasibility of laying fiber-optic cable along its rights-of-way and offering phone service;

2) Wiltel Communications Systems, now part of long-distance carrier LDDS, ran its own fiber-optic long-distance lines in conjunction with gas pipelines;

3) in Britain, 12 electric companies created Energis, a 2,000-mile fiber-optic phone system; and

4) AT&T is helping New Jersey's Public Service Electric & Gas Company develop a system to read meters and offer other services using lines laid down its rights-of-way.

While utility companies in the United States may become involved with providing fiber access along their rights-of-way, industry insiders feel it is unlikely they will actually get into the business of providing access directly to homes and businesses.

Baby Bells and Hollywood

A byproduct of the telephone companies' desire to enter the cable television business is their need for programming to put on the new video channels. To meet this need, the telephone companies are exploring possible alliances with the entertainment industries. In 1995, three RBOCs (Ameritech, BellSouth and SBC Communications) joined the Walt Disney Company to invest $500 million in a venture to supply movies on demand and other interactive entertainment services to 50 million telephone customers in 19 states. Three other RBOCs (Bell Atlantic, NYNEX, and Pacific Telesis) have joined forces with California-based Creative Artists Agency. This positions them to go into direct competition with the cable television companies. The RBOCs see program acquisition and development as the way to differentiate their video services from those of the cable companies.

Alliances, Mergers, and Partnerships

To share the cost of entering the telephone market and to gain the switching expertise they need, some cable companies are seeking alliances within the cable industry and with telephony companies. In the fall of 1994, cable companies Tele-Communications Inc. (TCI), Cox Enterprises Inc. and Comcast Corp. joined long-distance provider Sprint to set up a multibillion-dollar, nationwide telephone joint venture. Their aim is to provide a single package of services that would include PCS, cellular and regular local phone services, as well as cable television and long distance service as a single package. In the spring of 1995, Cablevision Systems Corporation, the nation's sixth-largest cable company, struck an agreement to interconnect with NYNEX customers in New York. Meanwhile, Time Warner has reached an agreement with the local independent phone company in Rochester, New York, to begin offering both cellular and traditional phone service in 1995.

In 1993, US West bought 25 percent of Time Warner Entertainment. Not only does this bring cable expertise to the telephone company, but it also brings telephone expertise to Time Warner, which plans to offer telephone service in New York City, where it currently operates a cable system with one million subscribers. Also in 1993, Southwestern Bell (now SBC Communications) bought Hauser Communications, a cable company in suburban Washington, D.C., and entered into a partnership with Cox Cable (now Cox Communications) to jointly operate 21 cable systems across the country. Meanwhile, NYNEX has invested $1.2 billion in cable giant Viacom.

The merger that has probably gotten the most attention in the last few years, however, occurred when AT&T purchased McCaw Cellular Communications. Suddenly there was a wireless powerhouse with nationwide presence and terrific brand-name recognition, and the cellular world sat up and took notice. Some of the RBOCs, not wishing to be left behind, joined forces as well: Bell Atlantic and NYNEX combined their cellular companies, and US West formed a pact with AirTouch, the cellular business that had been part of Pacific Telesis.

Many industry insiders believe that over the next 25 to 30 years, mergers and alliances will result in a handful of megacorporations providing a range of wireless communications and functioning as a single source for virtually any communication product from voice to video to data. Not only will this affect the United States, but it will affect other countries as well, including underdeveloped nations who will skip the wired network stage and jump directly to wireless communications.

Networks

POTS and PANS

Plain old telephone service (POTS) refers to the standard single line telephones, telephone lines and access to the public switched telephone network. It is simply dial tone and access, with no added features.

PANS is a term that was coined to describe the opposite of POTS. It stands for Pretty Amazing New Services and was originally used to describe the services that would become available with Integrated Services Digital Network (ISDN). ISDN has gone through a roller coaster ride of popularity. At first it was the answer to all transmission problems, then it was unnecessary, now it is regaining popularity in some camps, while others say it is still not needed. With the development of asynchronous transfer mode (ATM), the push to implement ISDN may again be sidetracked. ATM is a type of fast cell switching that can provide the constant bit rate service associated with circuit-switching and the variable bit rate service associated with packet switching. Regardless of whether PANS continues to refer to all of the new services that will be available through digital, packet switched, multiplexed networks, POTS appears to be going the way of the Model T.

Digital Transmission

The advent of digital technology has changed forever the face of the telephone industry. Digital signals can be used to transmit various types of signals (voice, data, video) faster and at a higher volume than can the typical analog telephone signal, and the message is practically error-free. Digital technology makes it easier for the phone companies to roll out new telephone services in a timely manner and to move into other businesses.

Fiber-optic Cable

Although everyone agrees that fully fiber-optic networks would provide the greatest capability and flexibility for transmitting various types of signals, the cost of installing fiber-to-the-curb (FTTC) throughout the country is prohibitive. However, in some high-density urban areas that have extensive networks of conduit and regular manhole access, FTTC is a possibility that is being explored. An end-to-end fiber system is easily capable of transmitting 1,500 voice channels simultaneously. Although this may seem like overkill at this time, since at this point we can see little reason for the normal household to receive more than five or ten simultaneous channels, who knows what services and products will become available in the coming decades? At any rate, fiber will continue to be the transmission medium of choice for wired networks.

Advanced Intelligent Networks

In an intelligent network, a combination of computer and communications technologies direct the routing of calls through the network based on parameters other than the next available time slot. Various forms of intelligent networks have been around for years. AT&T’s version of the intelligent network is called the Advanced Intelligent Network (AIN). AIN is available throughout most of North America. The advanced intelligent network lays the foundation for many new services, some of which are already in various stages of development and testing. These services include mixed voice, video and data traffic on variable-bandwidth switched lines, and personal telephone numbers that follow a user through the network. In addition, an advanced intelligent network uses its software to quickly and efficiently implement changes, without changing wiring or other hardware. One of the most popular of these change options involves system-wide control functions, which make it easy and cost efficient to upgrade existing services as well as add new ones.

Cellular and Personal Communications Services (PCSs)

By the turn of the century, cellular service will be as common and cost efficient as the corner phone booth, handheld communicators will permit communication (both voice and data) from anywhere on Earth, and networks will automatically deliver calls to people wherever they are. Although cellular services currently consist primarily of voice transmissions, it is estimated that by the year 2000 one-third of the calls placed will be for data transmission.

Personal communications services (PCS) will make portability the norm among communications users, transforming the way all networks, including existing networks, are used and managed. New services will range from pagers that take and display messages as well as telling the sender that the message was received to electronic dashboard displays delivered by radio transmission to tell the driver the best route to drive or where the best restaurants are in the next town. One of the major differences between the cellular services currently in operation and PCS capabilities of the future is the fact that PCS will be nationwide.

It will take a few years, however, before the PCS networks will be in place. There are still some skeptics who point to the huge costs involved in building the new PCS networks and requiring people to replace their old cellular phones with new ones that can use PCS frequencies; but most insiders agree that it will happen. The nationwide access and number portability promised by PCS have great appeal to a large portion of the population.

Although the original view of PCS was that it would take the place of cellular, that now doesn't appear to be true. Cellular phones are getting smaller, and many of the services that were thought to be only possible with PCS, such as single phone numbers and E-mail add-ons for use nationwide, are available today or will be in the near future from cellular carriers. Where PCS may have an advantage is in the video field. Cellular companies don't have the bandwidth necessary to handle video signals and PCSs do, although there are currently no plans to use this PCS video capacity yet. Many now feel that PCS will probably be a strategic supplement to cellular, both working together to create huge wireless networks.

Technology

Asynchronous Transfer Mode (ATM)

Asynchronous transfer mode (ATM) is a packet switching and multiplexing technique that uses information packets of identical size and allocates bandwidth on demand  . It is the state-of-the-art for high-speed connections of voice, data and/or video services. ATM is especially beneficial when transmitting video or voice messages because time delays are shorter and of more predictable duration than those experienced with frame relay systems. ATM systems are currently being tested by the National Aeronautics and Space Administration (NASA), Amoco, the University of Virginia and others. An

ATM Forum is working on standards, which the members hope to implement in late 1995.

Telecommunication experts have thrown their support behind ATM as the best method for handling huge volumes of data, voice and video transmissions. Cable companies and phone companies are both planning to use the new ATM systems to support the growing variety of services they hope to provide to their subscribers. However, industry experts believe it will be another two years before ATM equipment will be readily available.

Voice Recognition

Television's *Star Trek* characters speak into a communicator they wear on the chest portion of their uniform. The computer controlling their communications automatically responds to each individual's voice and performs the services requested. Science fiction? Maybe, but not for long.

Recently, voice-activated service started to appear as part of some telephone companies' offerings. Ameritech, Southern New England Telephone (SNET), and Bell Atlantic are testing various voice dialing services, while Sprint has introduced a voice-activated long-distance calling card.

There are three types of advanced voice technologies being reviewed by the telephone companies: speaker-independent recognition, speaker-dependent recognition and speaker verification. Speaker-independent systems are already in operation in some areas. These systems recognize certain words regardless of who says them and are typically used to recognize digits for phone numbers or identification purposes. Speaker-dependent and speaker verification systems must "learn" the voice and words to recognize, and require the user to set up and enter a pre-planned word or number list. Speaker-dependent systems are generally used for user-specific items like a phone number list. Speaker verification systems are usually designed for security and will only respond to the correct voice.

More tests are needed to refine these technologies, however. Difficulties have arisen from the systems' inability to understand common speech patterns or the variances used to say the same thing. Not only must the systems be programmed, but the users must also be taught to speak in a certain order, using only words programmed into the system. Although problems still exist, voice recognition systems will eventually be a part of the telephone industry.

Another impetus for voice recognition comes from the computer industry. Although it is now only relegated to science fiction stories, the voice-activated computer is a possibility that is being seriously explored. Voice recognition for the telephone industry will come first, using set vocabularies and commands. But, once perfected, it will become the stepping off point for voice-activated computers that will respond to myriad commands. Some simplistic (and expensive) programs have already been developed, but true multi-use, voice-controlled programs are still in the future.

Video Dial Tone

ADC Telecommunications was the first to market a hybrid fiber/coaxial (HFC) system designed to combine video and telephony traffic. The system, called Homeworx, has been picked up by Ameritech for interactive video, information, and entertainment. Ameritech anticipates using Homeworx for an advanced video dial tone system that will serve 1.2 million customers.

AT&T Network Systems also has contracts with Bell Atlantic, GTE, Pacific Bell, and Southern New England Telephone for HFC-based advanced video dial tone networks. Other RBOCs and some cable companies are testing different HFC systems as they rush to compete for video dial tone service.

BellSouth plans a 12,000-home video dial tone trial in Georgia in the spring of 1995. Their planned service offering will include 60 analog and 300 digital channels and will test two separate network architectures. BellSouth is investigating various programming categories, including movies, shopping, games, computer on-line services, education and time-shifted news.

In the spring of 1995, Ameritech began building new two-way video networks for use in some Midwestern communities by the end of 1995. Ameritech has contracted with Scientific-Atlanta, Inc., a major supplier of cable television converters, to provide analog and digital set-tops called home communications terminals. These terminals will be used for Ameritech's entrance into the interactive video dial tone business. Ameritech plans to provide video on demand (VOD), games, education, shopping and other interactive services.

Phones and Computers

The integration of telephones and personal computers (PCs) is already commonplace, with almost every new PC containing a modem to allow the PC to communicate over telephone lines. Some newer PCs also have built-in phone answering machines and speakerphone capabilities. On the drawing board are PCs that will provide full telephone services, such as call forwarding and caller ID, through the computer. In addition, plans are being made to make all of these services available on laptop-size PCs.

Unfortunately, this integration may not be readily available in many business systems because of the equipment differences among the various manufacturers. The major manufacturers, like IBM and AT&T, are currently working to overcome these incompatibilities.

A separate technology that may finally see acceptance because of the integration of PCs and telephones is the video phone. Today's PCs offer a much better picture quality than the video phones of the past; and since the users will already have a computer monitor in front of them, having the image of the person to whom they're speaking on that monitor may be desirable. As prices come down and quality goes up, this technology could finally become a reality.

Regulation

There is one major obstacle that stands in the way of the telecommunications revolution — regulation. The drive to regulate monopolies has lost its supporters in the United States and all around the world. There is virtual agreement from all players that it is time to reconsider the market structure.

In 1994, the House of Representatives voted for the first major revision of communications law in 60 years; however, the bill didn't make it through the Senate.

Infighting between the Democrats and Republicans plus strong lobbying by the various factions (IXCs, RBOCs, CAPs, independents, and PCS proponents) have kept telecommunications reform in a constant state of flux. But it is only a matter of time before the telephone industry becomes an open, truly competitive environment. It may take a few years before all the kinks are worked out and all the "ifs, ands, or buts" are removed, but all indicators point to a market that will allow any company the opportunity to offer local telephone access, long-distance service, wireless communications, video on demand, Internet connections and a host of other services.

Three RBOCs (Ameritech, Pacific Telesis and NYNEX) have already proposed opening their local-service monopolies in exchange for long-distance rights in their regions. Along with the other four RBOCs, they promise significant cuts in long-distance rates if they are allowed to compete with AT&T, MCI and Sprint, who now control 90 percent of the long-distance market.

Universal Service

Although opening the telephone industry to full competition has a lot of support, a major stumbling block has been how to maintain universal service. Even the definition of universal service is under debate. In the past, universal service was POTS, basic simple access to the network. Now, though, there is a move to define universal service as access to the information highway, not just to a telephone dial tone. In other words, everyone should have access to a network that would allow voice, data and video transmissions. This does not mean subsidized access to HBO, but it does mean potential access to an Internet-type service.

The ideal way to provide universal service would be to wire every home and business with fiber-optic cable. Unfortunately, this would cost billions of dollars and take years to complete. As things currently stand, telephone wires run to 98 percent of U.S. homes and businesses, while cable television lines reach approximately 63 percent (and run nearby almost 96 percent). In addition, the telephone companies are finding ways to send more and more data down their twisted-pair copper wires and are upgrading the rest of their networks. And, although the cable companies currently have access to fewer homes than the telephone companies, their coaxial cables are capable of handling more services.

A new twist to the universal access issue may be offered by cellular technology. If cellular services became available everywhere, it would no longer be necessary to run wire or cable to a home. Theoretically, all communication would be handled through wireless connections, either cellular or PCS. This scenario is already occurring in some areas. US West was recently ordered to subsidize the cost of a cellular phone and cellular service to homes that had not been wired for telephone service within 30 days of their request. Nevertheless, it is clear that certain geographical and residential markets will never provide the subscriber density to justify the expense, either wireless or wired.

The World View

Not only is the telecommunications industry exploding in the United States, but it's exploding world-wide as well. International calling has been the fastest growing part of the telecommunications industry for the last decade, and this trend is expected to continue. The opening of global businesses is creating the opportunity for global telecommunications competition. And the RBOCs and long-distance providers from the United States are jumping on the bandwagon. For example, NYNEX is building a cable television/telephone system in Thailand; AT&T is helping set up and run a telephone system in the Ukraine; GTE is building a cellular network in Argentina; and Sprint has joined forces with a Canadian long-distance carrier. This global involvement is expected to continue and grow. Some insiders believe the international telecommunications community will eventually be dominated by five or so megacorporations that provide for all of the telecommunications needs of the world.

Summary

The telephone companies are rushing to add video-on-demand and interactive services, while the cable television companies are restructuring their infrastructure to support telephony. Three beliefs are fueling these moves:

1) video-on-demand and interactive services like home shopping will be profitable;
2) the commercial market wants a two-way network for communication, file transfer, video conferencing and electronic commerce; and
3) the Clinton administration will require universal access to communication and information.

With competition on the horizon, the telephone and cable companies, along with consortiums of other companies, are field testing the new technologies and the markets. Mergers, alliances, buyouts and partnerships are changing the telecommunications industry, while service distinctions among the various players are blurring. The telephone industry may soon lose its identity in the larger industry known as telecommunications.

u contributed by Linda Stranahan, with Nancy Muenker and Leigh Ann Shevchik

Teleport

A communications distribution center that receives and transmits voice, data and video information via satellite, fiber optics and microwave for local, regional, national and international communications.

The first teleport, Teleport Communications — New York (TCNY), resulted from a partnership between Merrill Lynch Telecommunications, Inc. and Western Union Communications Systems, Inc. In 1985, TCNY began service over a fiber-optic network and satellite system that spanned Manhattan's business district and extended into the New York City boroughs of Brooklyn, Queens, and Staten Island and the New Jersey cities of Newark, North Brunswick and Princeton. By 1989, the teleport served more than 65 customers, which included long-distance carriers, financial services companies, broadcasters, newswire services, New York Stock Exchange traders and brokerage houses. At that time, TCNY's network of 19 satellite earth stations could communicate with any domestic or Atlantic INTELSAT satellite. The company changed its name to Teleport Communications Group (TCG) to reflect its expansion into additional metropolitan areas.

To the south, the Washington International Teleport (WIT) began serving the mid-Atlantic region from an eight-acre facility. By 1989, WIT's 23 earth stations offered access to all domestic satellites and five of INTELSAT's six satellites. Moreover, its 2,000-mile microwave network linked into the Williams Telecommunications Group fiber-optic system, which spans the United States. WIT also provided full-duplex television service between Washington, D.C., and broadcasting entities in Europe, Central America and South America.

Teleports offer several attractive benefits to business clients. First, they provide high quality voice and data transmission at significantly reduced costs. As a result, small companies can participate in arenas that otherwise would be cost-prohibitive. For example, using WIT's Capital Coverage Service, U.S. and foreign broadcasters have instant access to the State Department and other sites in Washington, D.C., without incurring the high costs of dedicated lines or satellite uplink trucks. Likewise, local stations can relay news feeds about their regions without establishing their own transmission facilities in the capital or relying on larger networks.

Second, teleports serve as a back-up to primary circuits supplied by the telephone companies. The criticality of uninterrupted voice and data communications has made alternative carriers a necessity for many businesses.

Two basic types of teleports have evolved: stand-alone and real estate-based. Stand-alone teleports, often called gateways or antenna farms, service customers in a specific geographic area through local distribution systems. They traditionally consist of a grouping of satellite antennas and a fiber optic/coaxial cable network. Video transmission, such as uplinks for television networks, cable feeds and video conferencing, is a predominant application.

Real estate-based teleports are located in or adjacent to business parks and provide shared telecommunications services to their tenants. Typical services are telephone private branch exchanges (PBXs) and badge-controlled access to buildings. Bay Area Teleport, near San Francisco, and Dallas Teleport are examples of real estate-based teleports.

By 1990, about 10 teleports operated nationwide, connecting business park tenants and major sites of banks, brokerage firms and other customers via private networks. Cable television operators eager to expand into telephony were becoming increasingly interested in the opportunities that teleport ownership offered, and in 1992 two cable companies, Tele-Communications Inc. (TCI) and Cox Enterprises, purchased TCG to move into position as competitive access providers (CAPs).

Subsequent regulatory changes enabled teleports and other CAPs to expand their range of service offerings by permitting interconnection with local telephone companies. For cable companies, especially those already using fiber-optic architectures, these changes have made it possible for them to become significant players in the telecommunications arena.

In 1993, Comcast Corporation and Continental Cablevision joined TCI and Cox Enterprises as co-owners of TCG. Through joint venture arrangements, TCG and seven cable companies now operate advanced fiber-optic-based systems in 13 major U.S. cities: Boston, Chicago, Dallas, Detroit, Houston, Los Angeles, Miami, Providence, Phoenix, San Diego, San Francisco, Seattle and St. Louis. Besides conventional teleport services, TCG's owners envision eventually using the company's teleports for personal communications services (PCS), video telephony, energy utility communications and a variety of data services.

u contributed by Nancy Muenker

Teletext

Teletext refers to the technology that enables text to be imbedded in a standard television signal for transmission, then displayed on a television set that is equipped with a special decoder. The text is carried in the vertical blanking interval (VBI) of the television signal. The VBI is the black line that is not normally seen but becomes visible when the vertical hold knob on a television set is turned. The VBI is composed of 21 lines that contain signal information and tell the television set when one picture ends and another begins.

Coded text can be transmitted on one of the VBI lines, then decoded by a special device that is either built into the television set or attached to it. Teletext is a one-way system that cannot be used by viewers to interact with the information or the sender.

Although teletext can be used to deliver a wide variety of text and graphic information, its most common use is for *closed captioning,* a printed representation of the spoken portion of a television program. It's called "closed" because a special decoder must be used to receive it. Hearing-impaired people can use closed captioning to see the spoken portions of a telecast. For live programs, the text is typed as it is spoken. For prerecorded programming, the text is keyed in ahead of time and synchronized with the visual portion of the program. Closed captioning was first used March 16, 1980, when NBC and ABC closed captioned several of their programs. By 1989, virtually all prime-time broadcast programming was closed captioned.

Except for closed captioning, teletext has not developed into a major service in the United States, although there are several companies active in teletext. For example, Southern Satellite Systems delivers a teletext service by satellite that is seen in the VBI of superstation WTBS. Less successful was Extravision, an effort by CBS to provide local classified advertising to supplement normal commercials. Poorly received by both advertisers and network affiliate stations, it was discontinued in 1984.

More recently, various cable channels have used teletext to carry news stories (Associated Press, Reuters, Tribune Media Service), sports (Cable SportsTracker), stock market reports (DBC/MarketWatch), program guides, and children's stories (Genesis Cable Storytime).

As a separate service, however, teletext has never been as popular in the United States as it has been in Europe. For example, teletext service has been available in Great Britain since the 1970's. Over seven million British television sets are equipped to receive CEEFAX, a teletext service of the British Broadcasting Corporation that provides news, weather and sports information, and Oracle, an independent teletext service.

u contributed by Paul Stranahan

Time Warner Cable

A wholly owned division of Time Warner Inc., Time Warner Cable is the second largest multiple system cable television operators (MSOs) in the United States. Based in Stamford, Connecticut, Time Warner Cable has a legendary history that includes the powerful pairing of Time Inc. and Warner Communications. Its original cable system, Sterling Manhattan Cable, was established in 1965 in New York City.

Time Inc., publishers of a variety of hugely popular magazines, including *Time* and *Life*, was founded in 1922 by Henry R. Luce and Briton Hadden. Founder Luce retired from the position of Editor-in-Chief in 1964 and died in 1967. From its earliest history as a publisher, Time Warner, through an amazing array of mergers and acquisitions, is now the largest media and entertainment organization in the world.

The very beginning of Time Warner Cable can be traced back to New York City in the mid-1960's. In 1965, Charles Dolan, now Chairman and Chief Executive Officer of Cablevision Systems Corporation, started Sterling Manhattan Cable. This venture got off to a precarious start, since the original cable system was in an urban area where viewers saw no real need for cable television, and it struggled financially.

One of the investors in Sterling Communications, the holding company for Sterling Manhattan, was Time Inc. Due to eroding sales of one of its flagship publications, *Life,* Time Inc. elected to try to shore up losses by investing in broadcast properties in several markets, including Minneapolis, Indianapolis, Denver, and San Diego. By 1970, however, the management team of Time Inc. decided to sell its television stations and concentrate on cable instead. But the company encountered many obstacles as it attempted to secure cable franchises. Some sources believe that the management team of Time Inc. thought its well-known name would give the company a sizable advantage in securing cable franchises. This wasn't the case, however, and the company found it slow going from 1969 to 1971. During this time, it won few of the systems for which it bid.

Throughout all of this activity, Time Inc. held on to Sterling Manhattan, in which it had acquired controlling interest in 1971. But the heavy financial losses that Sterling incurred were troublesome indeed.

In an effort to fend off a financial disaster, Dolan conceived the idea of creating a cable channel that offered viewers commercial-free telecasts of sports events and feature films. This new programming service could be offered to existing subscribers for an additional fee, over and above the existing $5 monthly subscriber fee, and would provide Time Inc. with an additional source of revenue. In an effort to explore this possibility and convince management of its viability, Dolan hired an attorney named Gerald Levin, who had contacts at Madison Square Garden. Time Inc. agreed to the idea, and this revolutionary concept eventually came to be known as Home Box Office, or HBO. And its success to date is legendary.

However, because of the company's continuing financial pressures, Dolan left HBO in l973, and Levin succeeded him as President. It was Levin who subsequently foresaw the possibility of expanding HBO programming to other cable markets beyond microwave relay and — most importantly — using satellite transmission as a means to feed programming to distant markets. In a landmark move, Time Inc. leased 12-hour-per-day satellite transmission service on Satcom I, which was successfully launched by RCA in 1975. Later that year, Time Inc. began feeding HBO to other cable systems.

In the meantime, Time Inc. had traded almost all of its cable systems to Denver-based American Television and Communications, Inc. (ATC) in 1973, for ATC stock. It also tried to find a buyer for Sterling Manhattan Cable, but was unsuccessful.

Then, after a change of heart, Time Inc. decided to get back into the cable industry and in 1978, it acquired the remainder of ATC. In addition, Manhattan Cable, including the original Sterling Manhattan Cable system, became part of the ATC subsidiary of Time Inc.

Warner Brothers became a player in the young cable industry as a result of corporate mergers and acquisitions. Because Warner Brothers, the film studio, had faltered under the leadership of Jack Warner, it was acquired by Canadian Seven Arts Productions in 1967. Two years later, Warner Brothers was acquired by Kinney National Services in New York, led by Steven J. Ross. Ross at that time was a bit of an unknown to the entertainment industry. In fact, his background was quite eclectic.

In 1954, Ross began as an executive trainee at Riverside Memorial Chapel in New York. His notion that the limousines owned by the funeral chain should be put to use in the evenings led to an incredible story of corporate growth. Ross started the limousine leasing service called Abbey Rent-A-Car, and once it was in place, he added parking to the package through an arrangement with Kinney Parking. This new business, renamed Kinney National Services, went public in 1961. In succeeding years, other businesses were added to the corporate mix, including National Cleaning Contractors. Soon after, Ross decided the conglomerate needed an entertainment component. Thus, in 1967, he added the theatre agency Ashley Famous, headed by Ted Ashley.

In 1969, due in large part to Ashley's experience and contacts within the entertainment and film industry, the organization acquired Warner Brothers Seven Arts for a price of $400 million. Part of the package included two record companies — Warner Reprise and Atlantic Recording.

Ross reorganized the entire business structure in 1971, selling some of the companies and renaming others. After retooling the company, Ross renamed the primary portion of the newly restructured organization Warner Communications in 1972.

One of the first business moves of the reorganized Warner Communications was to invest in the cable television industry. The company bought TeleVision Communications Corporation and the Continental Telephone Corporation. Next, it purchased Cypress Communications Corporation. With this acquisition, it became one of the biggest cable companies in the country.

But it was a rocky road for the cable industry during the next few years, due in large part to the massive restrictions placed on cable television (CATV) by the Federal Communications Commission (FCC). Warner Communications maintained its subscriber base and tried to weather the storm. As the future for cable improved substantially in the late 1970's, Warner Communications sold 50 percent of its cable division, Warner Cable Corporation, to American Express for $175 million. The new company became Warner Amex Cable Communications. In 1977, this venture launched a new interactive cable service in Columbus, Ohio, called QUBE. This service eventually was expanded to several other markets. The Warner Amex Cable partnership is perhaps best known for its very successful Music Television (MTV) Channel, which it launched in 1981.

In 1990, Time Inc. merged with Warner Communications, and the new company became Time Warner Inc.

It's important to note that Joseph J. Collins, current Chairman and Chief Executive Officer of Time Warner Cable, now based in Stamford, Connecticut, came up through the management ranks of ATC prior to being named President of HBO in 1984, and subsequently being named to his current leadership role of Time Warner Cable. Gerald Levin has continued his rise through the corporate leadership ranks and is highly respected today as Chairman and Chief Executive Officer of parent Time Warner Inc.

In early 1995, in the continuing quest to enhance its position in the cable industry, Time Warner Cable entered into joint venture and took over management of Newhouse Broadcasting Corporation, a wholly owned subsidiary of the very large Advance Publications, Inc., which also owns Conde Nast Publications and numerous other holdings. In 1994, Newhouse Broadcasting was one of the largest cable television operators in the United States.

With the merger between Time Warner and Newhouse Broadcasting, Time Warner Cable acquired an additional 1.4 million subscribers. As one of the largest multiple system cable television operators in the country today, Time Warner Cable serves more than 11.5 million cable subscribers in 37 states. In addition, the company anticipates that it will finalize purchasing the cable systems of Summit, KBLCOM and Cablevision Industries Corporation before the end of 1995.

With international name recognition, Time Warner's cable television subsidiary is set to explore opportunities in the budding video telephony market with new business partner U S WEST.

u contributed by Valerie Switzer

Editor's Notes:
Time Warner Inc. acquired Turner Broadcasting System Inc. in the fall of 1995. Shortly after the deal was announced, Michael Fuchs resigned as the head of Warner Music and Chairman of HBO.

A number of major companies are working together to develop Intercast technology, an interactive data delivery medium conceived by Intel. The Intercast Industry Group's goal is to create a service which combines television technology with the World Wide Web, allowing end-users to jump between television shows and web pages with the click of a button on a remote control. Companies involved in the effort include Intel Corporation, Continental Cablevision Inc. (under the ownership of US West), Tele-

Communications, Inc., Time Warner Cable Programming, General Instrument Corporation, TCI's Headend-in-the-Sky, NBC, Turner Broadcasting, Viacom International, WGBH Educational Foundation, QVC, America Online, Asymetrix, En Technology, Netscape Communications Corporation, Gateway 2000, and Packard Bell.

Collins, Joseph Jameson (1944 –)

American telecommunications executive and industry activist, Joseph Collins is Chairman and Chief Executive Officer of Time Warner Cable, one of the ten largest cable television operators in the United States.

Joseph J. Collins was born in Troy, New York, on July 27, 1944. He grew up in New York, and earned an AB degree in International Relations from Brown University in 1966. For the next four years, he served as an officer in the United States Navy. He received an MBA degree from the Harvard Graduate School of Business Administration in 1972. He married Maura McManmon on June 3, 1972.

Collins began his career with American Television and Communications (ATC) in June 1972 as Marketing Director of ATC's cable operation in Orlando, Florida. Interestingly, he was the first marketing specialist hired in the ATC cable family. He was named General Manager of the organization's central Florida division in 1973. In September 1974, he was transferred to ATC's corporate headquarters in Denver, Colorado, where he was named Division Manager.

From there, he quickly moved up ATC's corporate ladder. In 1976, he was promoted to Vice President of Eastern Operations for ATC. He was appointed Executive Vice President of the division in 1980, and assumed the title of Senior Executive Vice President in 1981.

Collins was named President of American Television and Communications in March 1982, and was responsible for cable systems operations, construction, engineering, programming and marketing. In October 1984, he was named President of Home Box Office, Inc. (HBO), the wholly owned programming subsidiary of Time Warner Inc.

In June 1988, Collins was named Chairman and Chief Executive Officer of American Television and Communications. This organization was merged with Warner Cable Communications to become Time Warner Cable. In September 1989, Collins was named Chairman of Time Warner Cable, a position he has held since that time. Time Warner Cable is the second largest cable television operator in the United States, with more than 11.5 million cable subscribers. The company's corporate headquarters are based in Stamford, Connecticut.

Collins is a past Chairman of the Board of Directors of the National Cable Television Association (NCTA). He was Vice Chairman of the NCTA in 1991. In addition, he has served on the Boards of Directors of the Turner Broadcasting System (TBS) and Tristar Pictures. Collins and his wife and their four children live in Darien, Connecticut.

u contributed by Valerie Switzer

Transistors

A device that controls the flow of electricity, consisting of at least three sections constructed out of a semiconducting material, such as germanium or silicon.

Developed in 1947 by Walter Brattain, John Bardeen and William Shockley at Bell Laboratories, the transistor started a revolution in electronics. Electronic devices were no longer beholden to fragile, temperamental, cumbersome and energy-hungry vacuum tubes. Transistors replaced these tubes and provided a solid-state method of controlling and switching electricity, which allowed products such as televisions, radios and computers to become much smaller, more reliable and more energy efficient. The Bell Labs trio won the 1956 Nobel Prize in Physics for their breakthrough work.

Though there is more than one type of transistor, all consist of a set of three electrodes embedded on a semiconducting material, such as germanium or silicon. The semiconductor allows the electricity to pass from one electrode to another in response to a control current. In this case, there are no moving parts, little heat, the output can be “dimmed” from full on to off, and the size of the transistor is much smaller than mechanical switches, relays or vacuum tubes.

One of the major benefits of this technology is its versatility. A transistor can be used as a switch, an amplifier, an oscillator, or a rectifier. The United States military was the earliest user of the transistor and applied this semiconducting technology to satellites, computers and radios. The invention of the integrated circuit in 1959 helped the evolution of electronics further by connecting transistors, resistors, capacitors and other components together onto a single integrated circuit or chip.

u contributed by Christopher LaMorte

Transportation System

A method by which information is sent from one point to another in a communication network.

A transportation system is often used in information delivery to move information, whether it is voice, data or video, from one specific point to another. In cable television, for example, a cable television transportation system allows signals to move from the area where television signals are first received (antennas and satellite dishes) to the area where they are processed (the headend) before being sent to customers. These two areas are often separated because the antenna should be kept away from other radio frequency sources in the area. Also, in some places, there is simply no room to construct large antennas or perhaps local laws will not permit them to be built. The transportation system joins the cable headend to these remote antennas.

In larger metropolitan areas, one cable headend is usually not capable of servicing the entire city. To alleviate this problem, hub sites are set up to send signals to areas that the headend cannot reach. In these situations, the transportation system is the network that connects the headend to the hub sites.

Transportation systems are also found in other types of information networks, such as those operated by telephone companies. For instance, the transportation system of a telephone network connects various switching offices (the signal processing centers of telephone networks). The transportation system moves a phone call from one switching center to another until it reaches its destination.

The most common method of sending signals in a transportation system is through trunk cable. Trunk cable has a greater capacity than ordinary cable and can carry more signals. It is equipped with amplifiers that keep the signal from becoming too faint as it travels to its destination. Fiber optic cable (which uses light waves to transmit signals) or microwave antennas (which use a high-frequency radio signal) can also be used to connect strategic points in a communication network.

u contributed by Christopher LaMorte

Turing, Alan Mathison (1912 – 1954)

English mathematician and logician who led the team of cryptoanalysts that broke the German Enigma code during World War II, primarily known for his pioneering and enduring contributions to the theory and development of computers.

Turing was born in London in 1912 and educated at the universities of Cambridge and Princeton. He worked as a cryptographer for the British Foreign Office during World War II, where his brilliant work with a team in breaking the German Enigma code helped the Allies ultimately defeat Hitler's air force. The team designed and constructed the first operational computer, called the *Robinson*, whose sole function was to break the Enigma code. Its more powerful successor was the *Colossus*, which Turing's team was forced to design after the Germans altered their code. The *Colossus* was the first British electronic computer.

Turing's pioneering work in computer theory includes a 1937 theoretical description of a universal computer, based on the work of Bertrand Russell and Charles Babbage, called the Turing machine. Considered his greatest accomplishment, the Turing machine still forms the basis of modern computational theory. That same year, working independently of each other, Turing and American mathematician Alonzo Church developed the theory that machine and human intelligence are essentially equivalent. This is now known as the Church-Turing thesis.

From 1945 to 1948, Turing supervised construction of the ACE computer at Britain's National Physical Laboratory. From 1948 on, he was Assistant Director of Manchester University's Computing Laboratory. Fascinated by the new technology's potential, in 1950 Turing devised a means for determining whether a machine is intelligent. Called the Turing test, it is the only widely accepted test of its kind. He also contributed to early computer programming techniques.

Alan Turing died at the age of 41 from self-poisoning, a probable suicide related to reports of his homosexuality and a prosecution for alleged indecency. Today he is considered one of the principal theorists of artificial intelligence as well as a brilliant contributor to the development of computers.

u contributed by Kay S. Volkema

Turner, Robert Edward “Ted”, III (1938 –)

American broadcasting entrepreneur, cable television pioneer, professional sports team owner and sportsman. Ted Turner is primarily known for establishing cable television’s first superstation (WTBS) and the first 24-hour news channel (CNN).

Born in Cincinnati, Ohio in 1938, Turner and his family moved to Savannah, Georgia, when he was nine years old. After attending military schools in his youth, he attended Brown University in Providence, Rhode Island, but left before completing his degree.

After leaving school, Turner briefly worked for the Coast Guard. Then he became an Account Executive with his father’s outdoor advertising company headquartered in Atlanta, Georgia, and was named General Manager of the Macon branch in 1960. Three years later, his father committed suicide because of business troubles. Turner inherited the floundering billboard company at the age of 25 and overcame many obstacles to bring the company back to profitability several years later.

Turner eventually sold the firm and entered television in 1970 when he purchased a small, independent UHF station in Atlanta. Within three years the station had become very profitable, despite being unaffiliated with any of the big three networks (ABC, CBS, or NBC). In 1976, he made a characteristically bold move by using an RCA Satcom satellite to deliver his local Atlanta station to cable subscribers all over the U.S., creating the first superstation, TBS Superstation. As more homes were wired for cable, the station and its revenues grew. Turner also conceived the idea of having TBS Superstation programs begin at five minutes past the hour, so its TV listings stood out from the others.

In 1980, Turner again made television history by establishing the first 24-hour news channel, CNN (Cable News Network). Just like TBS Superstation, CNN has not only been innovative but also very successful, and is a respected news organization worldwide. In 1988, Turner also launched TNT (Turner Network Television), utilizing feature films he acquired in his earlier purchase of Metro-Goldwyn-Mayer/United Artists film library. Turner “colorized” many black and white films from the 4,000-volume MGM library, arousing the ire of some critics and the film industry on the one hand, but pleasing his cable TV audience on the other.

An avid sportsman, Ted Turner is also well known for winning the prestigious America’s Cup yachting race in 1977 as captain of the *Courageous* and he was honored as “Yachtsman of the Year” an unprecedented three times. He currently owns both the Atlanta Braves baseball team and the Atlanta Hawks basketball team, purchasing both in the mid-1970’s. He was named Time’s Man of the Year in 1991.

In December 1991, Turner acquired the entertainment assets of Hanna-Barbera Cartoons, including their 3,000-episode library, distribution rights and production facility. The Hanna-Barbera collection includes such popular characters as the Flinstones, Yogi Bear, Scooby Doo and the Jetsons.

On October 1, 1992, Turner launched the Cartoon Network, the world’s first 24-hour, all-animation television service showcasing the Company's extensive library of cartoons. TNT and Cartoon Network were launched in Europe on September 17, 1993, offering classic films and animation programming in six languages. TNT & Cartoon Network in Asia Pacific, launched October 6, 1994, provides programming in English, with some programs dubbed or subtitled in Mandarin and Thai.

Castle Rock Entertainment joined the Company's entertainment division in December 1993. Castle Rock is the television and motion picture producer whose releases include *In the Line of Fire*, *When Harry Met Sally, City Slickers*, *Shawshank Redemption* and the television series, *Seinfeld*. In January 1994, Turner Broadcasting merged with New Line Cinema, the leading independent producer and distributor of motion pictures including *The Mask*, *Dumb and Dumber*, *Hoop Dreams* and *Seven*. April 1994 marked the launch of Turner Classic Movies (TCM), a 24-hour commercial-free network featuring the Company's library of film greats.

Today, Ted Turner is married to award-winning actress and fitness entrepreneur Jane Fonda. He is Chairman and President of Turner Broadcasting System, Inc. based in Atlanta. He has also expressed an interest in owning one of the big three networks after making an unsuccessful attempt to takeover CBS in 1985. In September 1995, he announced plans to merge TBS with Time Warner Inc., creating what would be the world's largest media organization. If the merger is approved, Turner would be Vice Chairman of Time Warner Inc. Turner is a bona fide media celebrity known as much for how he conducts himself and his life as for his many accomplishments as a cable pioneer and astute businessman.

u contributed by Kay S. Volkema

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U S WEST, Inc.

The regional Bell operating company (RBOC) — also known as a Baby Bell — that provides local phone service in a 14-state territory, as well as cellular, directory publishing and other information services.

U S WEST, based in the Denver suburb of Englewood, Colorado, is one of the seven regional Bell operating companies (RBOCs) — or Baby Bells — created by the 1984 divestiture of AT&T. U S WEST, which has the largest geographical region of all the Baby Bells, provides local phone service in 14 states: Arizona, Colorado, Idaho, Iowa, Minnesota, Montana, Nebraska, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington and Wyoming. Its other business interests include directory publishing — U S WEST publishes over 300 directories — and cellular services. With the six other RBOCs, U S WEST shares Bell Communications Research (Bellcore). In addition to Bellcore, the company relies on its own multi-million dollar research facility located in Boulder, Colorado.

Since the AT&T divestiture, U S WEST has often established itself as a trendsetter in the telephone industry. For instance, with its local phone service business growing minimally, U S WEST was the first Bell company to seek changes in the divestiture agreement that would allow it to expand into unregulated markets. In 1988, then-CEO Jack MacAllister shocked industry observers by removing Bell's name (synonymous with telephony since Bell first phoned Watson) from the U S WEST telephone companies' names and merging them into U S WEST Communications.

Under the leadership of current CEO Richard McCormick, U S WEST is upgrading its network using fiber optics and other new technologies. The company has also adopted a *one-stop customer service* philosophy and is streamlining operations by consolidating many of its customer service centers. Early in 1995, with U S WEST support, Colorado lawmakers began drafting state legislation that would allow competition in local phone service. U S WEST (and other RBOCs) contend that open competition coupled with eliminating profitability ceilings will benefit consumers and allow telephone companies to reap the financial benefits of operating more efficiently.

In July 1994, U S WEST and AirTouch (formerly Pacific Telesis Group's wireless business) announced plans to combine their domestic cellular operations to create the nation's third largest wireless telephone company. Later in 1994, the two also aligned themselves with RBOCs Bell Atlantic and NYNEX. The resulting company, PrimeCo, won access to 57 million potential personal communications services (PCS) customers during early 1995 federal auctions of airwaves. (PCS is a new technology that offers a higher capacity alternative to cellular phones.) Future plans for the joint venture include developing and marketing standardized, nationally recognizable products and services.

U S WEST is confidently moving forward on the information superhighway. Having invested $2.5 billion in Time-Warner, U S WEST will partner with the entertainment giant to launch telephone, information and entertainment services on Time-Warner cable television systems in domestic markets outside U S WEST's region. In addition, U S

WEST and RBOC SBC Communications, Inc. (formerly Southwestern Bell) have purchased cable systems that currently serve over 60 percent of the Atlanta market's cable customers. The move puts them in direct competition with fellow RBOC BellSouth, which is testing interactive television in the Atlanta area. Within its own region, U S WEST has committed $10 billion to bring video to current customers, beginning in several cities including Denver, Minneapolis and Salt Lake City. In addition, the company will test interactive services in 60,000 Omaha homes.

In the international arena, U S WEST and Tele-Communications, Inc. (TCI), the nation's largest cable television provider, have combined their European cable television and telephone services. U S WEST is also involved in other international cable television, cellular communications and personal communications systems ventures in countries including the United Kingdom, Sweden, Norway, Hungary, France, Russia, Slovakia and the Czech Republic.

u contributed by Susan P. Sanders

Editor's Notes:
US West bought Continental Cablevision for $10.8 billion in February, 1996. $5.5 billion is in cash and stock, while $5.3 billion goes to pay off Continental's debt. The deal gives US West over 16 million cable subscribers in the U.S., enhancing the company's investments in cable systems owned by Time Warner, Inc.

McCormick, Richard D. (1940 –   )

American business executive, currently Chairman, President and Chief Executive Officer of U S WEST, Inc., a regional Bell operating company (RBOC).

Richard McCormick was born in Fort Dodge, Iowa, on the Fourth of July in 1940. In 1961, just shy of his twenty-first birthday, McCormick received his electrical engineering degree from Iowa State University. The same year, he began his lifelong telecommunications career when he was hired on as an engineer at the American Telephone and Telegraph (AT&T) offices in Kansas City, Missouri.

After eight years with AT&T, McCormick transferred to Northwestern Bell, serving in various business units throughout Minnesota, Nebraska, North Dakota and South Dakota. From 1974 to 1977, he held the position of Vice President and Chief Executive Officer at Northwestern Bell in Fargo, North Dakota. In 1977, McCormick moved to New Jersey to rejoin AT&T as Assistant Vice President of Human Resources, and returned to Northwestern Bell in 1978 as a Senior Vice President. McCormick became Northwestern Bell's President and Chief Executive Officer in 1982.

Following the 1984 divestiture of AT&T, McCormick moved to Englewood, Colorado (a Denver suburb), to join U S WEST, Inc. as an Executive Vice President. In 1986, he became U S WEST's President and Chief Operating Officer. He was elected the company's Chief Executive Officer on December 31, 1990, and was named U S WEST's Chairman on May 1, 1992.

As a leader, McCormick is characterized as a builder — constructing alliances, developing consensus and translating vision into reality. The urge to create manifested itself early in his life. His kindergarten teacher recalls often finding him awake during naptime — always busy building something. That drive continues today.

U S WEST has experienced many firsts under McCormick's leadership. It was the first regional Bell operating company to consolidate its telephone companies, the first to begin to upgrade its facilities to prepare for multimedia, and the first to align itself with a cable television company to build interactive networks. McCormick's vision and leadership in telecommunications technology is complemented by his commitment to human development. He views workplace diversity as a key business strategy, as well as the right thing to do. U S WEST, under his guidance, has developed innovative job-sharing and telecommuting programs.

The U S WEST Foundation, chaired by McCormick, has established itself as a trendsetter in bringing together educators, elected officials and community members to develop collaborative solutions to community concerns. Often using advanced technology to facilitate communication, the foundation has helped link teachers with classroom resources, furnish businesspeople with information and capital, and provide communities with jobs and cultural activities.

In addition to his other responsibilities, Richard McCormick serves on the boards of Norwest Corporation and UAL Corporation. In addition, he is a member of the board of Creighton University in Omaha, Nebraska, a director of both the American Indian

College Fund and the Community Reinvestment Fund, and a trustee of the Denver Art Museum. McCormick is chairman of the U.S. Council for International Business, a member of the Business Roundtable and has served on the National Security Telecommunications Advisory Committee.

u contributed by Susan P. Sanders

United Paramount Network (UPN)

Headquartered in Los Angeles, California, United Paramount (UPN) is the very youngest of the national broadcast television networks. On January 16, 1995, UPN went on the air to 97 stations with two nights and four hours of programming planned and produced. Even though UPN is the most recent network entrant and not yet a prime-time threat, the company's history goes back a long way.

In the mid 1940's, the government forced movie studio Paramount Pictures to divest itself of its theaters. Those moviehouses, United Paramount Theaters, went on to team up with American Broadcasting (AB-PT), which, in turn, became known as the television network, the American Broadcasting Company (ABC). Meanwhile, Paramount Pictures continued to be a major player in film and television production.

In 1970 there was another government-forced divestiture that would have implications for Paramount. The Columbia Broadcasting System (CBS) was forced to divest itself of its cable television systems. As a result, CBS formed an independent company, Viacom, which went on to become an important player in the syndication arena as well as in ownership of radio and television stations and cable channels.

Paramount, now known as Paramount Communications, decided to enter the race to create new television networks. The new network was to be called United Paramount Network, or UPN, and it was launched by Chris-Craft Industries in 1995 with help from Paramount. Viacom Inc, Paramount's parent company, has an option to acquire 50 percent of UPN through 1997.

At the same time the government imposed the divestiture upon CBS in 1970, the Federal Communications Commission (FCC) also instituted another regulation that would have a major impact on fledgling networks more than 20 years later. The regulation in question was a set of rules commonly called the financial interest and syndication rules, or fin-syn. This set of rules was supposed to encourage entrepreneurial production and to discourage the tight control the big three national networks (ABC, CBS, NBC) had over production and syndication.

Simply stated, the fin-syn rules limited the amount of financial interest a network was allowed in the programs it aired and was restrained from domestically syndicating programs. While this measure did foster some outside production, it wasn't the boon to independent producers the FCC had hoped. It was very beneficial, however, for some Hollywood film production houses. During the late 1980's and early 1990's some limitations on portions of the fin-syn rules were loosened, and the FCC made plans for the entire list of restrictions to be eliminated by the end of 1995. Additionally, because the FCC had made station licenses easier to obtain, a large number of new independent stations broadened the market for syndicated shows and thus the opportunities for another network.

Prior to the elimination of the fin-syn rules, a television production facility could make hefty profits producing shows for the networks. But under the fin-syn rules, a production company would have to give up those profits to become a network. However, with the changing climate and changing rules, many production companies were rumored to be looking into this type of venture. And this course of action was exactly what Twentieth Century Fox did with its television network, Fox Broadcasting Company (Fox).

As early as 1989 the rumors of a fifth network parented by Paramount, MCA or Tribune were circulating. By 1993 the rumors became truth and on January 16, 1995, United Paramount Network went on the air. UPN was not to be the fifth network, however. The Warner Brothers Television Network (WB) beat UPN by five days. UPN was happy to finally be on the air and whether the network was officially number five or number six was immaterial. UPN planned to attack the three older networks in much the same way Fox had a decade earlier. Lucie Salhany , most recently Chairman of Fox, was named the President and CEO of UPN. Salhany's new network planned to be different, brasher, funnier, truer. UPN's plan was to start with two nights of prime time programming, Monday and Tuesday. In addition it would air a two-hour movie block on Saturday afternoons.

As UPN was busy lining up previously un-affiliated stations across the country, its programmers were busy looking for new opportunities. One seemingly can't-go-wrong programming move included the indestructible *Star Trek,* a Paramount property.

By February 1995, UPN had signed on more stations. The roster included 112 stations representing more than 84% of TV households. Growth will be a predictable struggle for both UPN and WB, however. Because they both premiered within days of each other they will probably always be linked and compared.

UPN, officially the sixth network, has all the certainty of an immortal teenager in that the old guys — CBS, NBC, ABC and even Fox — are too fixed in their ways and too unresponsive. But the larger question remains for all of today's television networks: will there be enough people to watch all that is broadcast?

u contributed by Michele Messenger

Salhany, Lucille S. (1946 –   )

American businesswoman and television executive, currently President and Chief Executive Officer (CEO) of the new Chris-Craft Industries' venture, United Paramount Network (UPN). UPN is a television network that premiered in January 1995. Lucie Salhany is arguably the most powerful woman in the network television business today.

When film production studios were allowed to break into the network ownership business through governmental rule changes, two prominent players stepped forward to take the challenge. Warner Brothers unveiled the Warner Brothers Television Network (WB) and Paramount helped launch UPN with Chris-Craft Industries. Viacom Inc., Paramount's parent company, currently has an option through 1997 to acquire fifty percent of the new network.

WB and UPN were similar in some basic ways: both debuted in mid-January 1995, and both had a former Fox Broadcasting Company (Fox) executive leading the way. WB is a joint venture led by Jamie Kellner, formerly President of Fox. UPN's leader is Salhany, the former Chairman of Fox. Kellner left Fox in the early 1990's when Salhany was named Chairman. After just 18 months leading Fox, Salhany left the fourth network (Fox) to head up the newest network.

In September 1994 Salhany was named President and CEO of UPN. As the network's plans for two consecutive nights of programming were shaping up, Salhany's main duties included programming, marketing and network distribution.

Prior to stints at UPN and Fox, Salhany was President of Paramount Domestic Television. Her division produced many successful syndicated shows, including *Star Trek: The Next Generation.* While at the domestic television division, which syndicates television shows, Salhany earned a reputation as an excellent businessperson, a self-described hands-on boss.

A mother of two, Salhany started her television career in 1967 at WKBF-TV in Cleveland. After a three-year stint as Program Director, she went to WLVI-TV in Boston as Program Manager. A Vice President of Television and Cable Programming stint with Taft Broadcasting Company came next. In 1985 Salhany moved to Paramount Domestic Television.

With the new network, Salhany's and UPN's launch pad included the obvious — the next *Star Trek* series, *Star Trek: Voyager.* Interestingly, this new program's starship is captained by a female, too. Salhany not only brings her experience from Fox with her but also Paramount's legendary *Star Trek* success. UPN's goals, starting with the two nights of programming in January 1995 were and are high. Salhany has publicly stated how difficult the new task will be. On many occasions she has already found herself defending the new network and its plans. However, a powerful woman like Lucie Salhany is probably all the new network needs.

u contributed by Michele Messenger

Vacuum Tubes

Patented in 1907 by Lee de Forest, the vacuum tube was the central component of electronic equipment until the early 1950's when it was replaced by the transistor. Consisting of a glass tube, a small wire filament, a metal plate and a grid, the device controlled or amplified the flow of electricity in a circuit.

The vacuum tube is the great grandfather of today's electronic gadgetry. By today's standards, this bulky glass tube seems primitive. Even by the standards of its day, it had its share of shortcomings and its temperamental nature frustrated the most accomplished engineers. The vacuum tube, however, occupied a central role in the development of computers, radio technology and telephony.

The vacuum tube gained such prominence through its versatility. It could be used as a switch, replacing moving mechanical switches, as a radio receiver or as a sound amplifier. These latter abilities made the vacuum tube useful in radio equipment and in telephones. As a switch, it performed much faster than its mechanical counterpart, allowing computers to perform a staggering amount of operations and calculations in record time. The 1946 ENIAC computer, for example, contained 18,000 vacuum tubes.

The basic design of the vacuum tube consists of a glass tube with all or almost all of the gas pumped out of it, creating a vacuum. The tube contains three or more metal elements: a cathode, an anode, and a number of control grids. When a charge is present, the gasless environment allows electrons to flow easily from the cathode to the anode, also called a plate. The grid's job is to control the electron stream as it travels between the points.

But vacuum tubes possessed many drawbacks. They were difficult and expensive to build and often simply would not work. They generated a lot of heat, which wasted energy. Vacuum tubes also exhibited a high failure rate. They were too big and too fragile to be used in portable devices. In 1948 the advent of the transistor eliminated these problems by incorporating the vacuum tube's functions into a tiny, solid-state component.

u contributed by Christopher LaMorte

Vail, Theodore Newton (1845 – 1920)

American executive, primarily known for leading Bell Telephone and AT&T to a premier position in the telecommunications marketplace and establishing almost universal telephone service in the U.S.

Vail was born in Minerva, Ohio, in 1845, cousin to Alfred Lewis Vail, who was partner to telegraphy pioneer Samuel Morse. Aided by early exposure to telegraphy, 19-year-old Theodore became an operator for the Western Union Company in New York City. Then he began a prosperous career in the railway postal service, beginning with a clerking position on western trains and ending with an appointment as General Superintendent of Railway Mails based in Washington, D.C.

In 1878, Vail left his government job and was hired as General Manager of the then-floundering Bell Telephone Company. Over his nine-year tenure, Vail's accomplishments were far-reaching and enduring. He unified the U.S. telephone industry and established a long-distance service by merging and interconnecting local exchanges, incorporating American Telephone and Telegraph (AT&T) in 1885 and serving as its President. To manufacture telephone equipment, he founded the Western Electric Company. Establishing the customer- and government-pleasing goal of providing the finest service at the lowest possible cost, he helped bring financial success to all these telephone companies.

In 1889, he finished his four-year stint as AT&T President and retired. Vail then went to Argentina to help construct a waterpower plant and a street railway. He returned to America in 1906 following the deaths of his wife and son.

Vail accepted the presidency of AT&T again in 1907 and continued breaking ground until 1919, when he retired. During his second tenure, AT&T joined forces with hundreds of local firms that had been competitors of AT&T when the Bell patents expired. The company also developed the first transcontinental telephone line and a transatlantic radiotelephone. Aiming to protect AT&T's ever-growing monopoly by supplying universal service, Vail strategically supported federal regulation of the industry.

During World War I, Vail expertly directed telephone services for the U.S. government. Theodore Vail died in 1920 in Baltimore, Maryland, one of the true pioneers in American telecommunications.

u contributed by Kay S. Volkema

Video Games

Today video games are a $5 billion market. An estimated 40 percent of U.S. homes have a video game system. Video game sales virtually tie the film industry in terms of revenue. In fact, the first week that a long-awaited video game hits the market, it can earn more money than a blockbuster movie. Video sportsmanship has indeed become more than a fad, making a distinct mark in the way people across the world entertain themselves.

The first video game, *Space War*, was invented in 1962 by two graduate students at the Massachusetts Institute of Technology. The game was simple, designed to be played on a black and white monitor with two joysticks. *Space War* and other games that immediately followed it became so popular on college campuses across the country that players often disrupted access to their school's mainframe computer.

In 1969, Ralph Baer, an electrical engineer with a mid-sized New Hampshire electronics firm, developed a ball and paddle video game for use on home sets. Magnavox marketed the product, called *Odyssey*, and it hit stores in 1972 carrying a price tag of just under $100. The machine came with six game programs and plastic screen overlays to provide the background for the games. *Odyssey* lacked the ability to keep score, so Magnavox also provided score cards.

Nolan Bushnell, who had played *Space War* at the University of Utah and also previewed a version of *Odyssey* at an electronics trade show, decided to build a coin-operated video game for arcade use. His first attempt, *Computer Space*, proved too complicated for arcade players and they showed little interest in it. Bushnell and former colleague Ted Dabney each contributed $250 to start Atari. They recruited engineer Al Alcorn to develop a simple computer game based on table tennis. This game, *Pong*, was an instant hit and Atari and copycat companies manufactured over 10,000 of them.

The success of *Pong* allowed Atari to lead the coin-operated video game market. By 1978 the company had developed a home video game system, the Atari 2600, capable of playing various games using cartridges that fit into the machine and that were sold separately. The 2600 failed to spark widespread consumer interest until Atari licensed the rights to make a home version of *Space Invaders*, a popular arcade game manufactured by Midway. With the success of the home video system, Atari experienced the fastest corporate growth in American history, with $2 billion in profits by 1982. Then, suddenly, the market fell apart. Competitors manufactured game consoles with better graphics and better games. Consumers also began demanding home computers that could do more than play games and turned to more sophisticated machines like the IBM PC.

In 1985, a Japanese company, Nintendo, revitalized the home video game market. The games Nintendo produced offered high-quality graphics and multiple levels of skill, which kept players interested longer. Nintendo surpassed Atari's peak popularity, enjoying $3 billion in profits by 1989. Companies such as Sega, 3DO and Atari have challenged Nintendo's market share with CD-ROM-based games utilizing 3-D graphics, live-action video, digital sound and powerful microprocessors. In 1994, Sega surpassed Nintendo as the best selling video game system. As the interest in video games peaks, companies will look at ways to expand their market to women and older men, who generally have shown little interest in video games.

u contributed by Christopher LaMorte

Video On Demand

A system that allows television viewers to select movies and other programming from a central video library without leaving their homes.

A person who wants to watch a movie at home basically has two choices: go to the neighborhood video store to rent a movie, or watch whatever happens to be on television that night. Video on demand (VOD) promises to provide another option. Instead of leaving home to rent a movie, a viewer can choose one from an on-screen menu sent by the local broadband service provider and order it using the remote control. The choice of videos will not necessarily be limited to movies. Home workout videos, last night's newscast, vintage situation comedies, educational material or any one of multiple selections could be accessed through this system. A VOD system will offer the same features as those found on a VCR, such as pause, rewind and fast forward. Other homes can also order the exact same program at any time they like, also pausing, rewinding and fast forwarding without interfering with anyone else's viewing. The video most likely will be a high-quality digital picture, offering superb color, resolution and movie theater-quality sound.

Because of these features, video on demand is one of the most widely anticipated services envisioned for future telecommunication systems. Video on demand's development depends upon several critical issues, however, including perfecting delivery methods, improving storage technology and resolving certain marketing concerns.

Delivery Technology
Digital information (such as full-motion video) generally requires networks with much greater bandwidth than the networks that currently deliver telephone service or cable television. Bandwidth refers to the amount of information a particular medium can carry at one time. Although twisted-pair wire (which is used in segments of the telephone network) and coaxial cable (which is used to deliver cable television) can support video to various degrees, video on demand requires a medium with even greater bandwidth. Interactive services — such as VOD — will most likely rely on fiber optic cable to deliver the large data flow that interactive services require. This type of cable offers a large bandwidth, meaning it has a lot of room through which to send information. Also, fiber optic cable maintains signal quality better than coaxial cable or twisted pair-wires when signals travel far distances.

Traditional cable, such as coaxial cable, offers large bandwidth but still may not be able to handle the all the data involved in sending digital video (and other types of interactive services) over great distances and to many homes at once. That is because as signals are sent through the coaxial cable and fed into many homes, they tend to become weaker. Also, as signals are split from a main coaxial cable into many individual homes, they degrade even more. Fiber optic cable can maintain signal quality over long distances better than coaxial or twisted pair cable. It also suffers less frequent problems than coaxial or twisted pair cable.

However, because of its large bandwidth, coaxial cable still can play an important role in video on demand networks. That is because digital data can be compressed so that it takes up less room as it is sent through a network. In such a situation, a converter (or set-top box) on the television decompresses the signal so the viewers can obtain a normal picture. Using compressed data, a video on demand network can be built using both fiber optic and coaxial cable. An example of this fiber/coaxial hybrid network is the Full Service Network (FSN) in Orlando, Florida, Time Warner's experimental interactive network started in late 1994. This system has taken advantage of compression technology to offer limited video on demand. Time Warner also plans to develop other interactive services as well through this hybrid network.

As with telephones, a network delivering video on demand services can get jammed when many people use the delivery system at one time. Compressing the signals delivered through the VOD networks, as well using sophisticated techniques to arrange the information traveling through the cable, will help develop a practical system and eliminate problems like network jams.

Storage Technology

The library that holds the videos in a VOD system will actually be a powerful central computer that has stored the videos as digital data. The videos can be stored on an optical medium, like a compact disc, or on magnetic disk drives. The central computer will also coordinate requests from viewers, acting as the center of a large computer network. Viewers send commands to this computer, called the video server, from their television sets when ordering a video-on-demand program. Because of the great quantity of information that will be stored, the video server will need to optimize its storage space by using digital compression techniques as well as the latest storage technology. Storage responsibilities may also have to be shared between multiple video servers. One such model proposes that a local video server, supporting a limited number of customers, stores the first 15 minutes or so of a film, while the rest of the film is stored at a regional — or even national — video server, serving several local servers. When a customer requests a movie, the local server sends the first 15 minutes, and then gets the rest from the regional server. The local server seamlessly blends the remainder of the movie with the part that has already been sent. This scheme reduces the storage space the local video server needs because it does not have to store the entire movie.

Marketing Concerns

Video on demand will be different from a video store, where customers can easily browse the aisles to see the variety of films offered. It will also differ from current television, where films receive a great deal of publicity before they air. These differences create special marketing problems for video on demand.

A central concern of video on demand will be cost. VOD customers will not likely pay much more for videos on demand than they currently do for videos at their local stores. Some estimate that a video on demand movie will cost as much as $1 higher than a rental. This price may be too high, however, according to some marketing experts.

Also, many video rentals are made impulsively. This is why movie studios pay a great deal of attention to how they package a video so it's attractive to customers. The marketing challenge for video on demand will be to stimulate the viewer's interest in movies with which he or she is unfamiliar. Clever graphics or "trailers" (movie previews) attached to other popular films may provide this incentive.

Finally, many consumers who have already made an investment in their video equipment may be reluctant to embrace a video alternative that basically renders their VCR obsolete. Despite these concerns, video on demand promises to be one of the most appealing services available on the information superhighway.

u contributed by Christopher LaMorte

Video Cassette Recorders (VCRs)

With its introduction in the 1970's, the video cassette recorder (VCR) made the concept of a home entertainment center a growing reality in most American homes. More importantly, according to one media observer, it ushered in the revolutionary "age of personal choice television."

The impact of VCR use has been felt in the plummeting market share numbers of the once mighty broadcast TV networks, in the explosive videocassette rental and sales markets, and in the advertising and marketing industries that are trying to deal with viewers using the fast-forward button on their VCRs.

Yet, like virtually all technologies, there's always something better on the horizon. Even the VCR may have already seen its best days. The burgeoning digital and compact disc technologies may be joining forces to usurp the VCR's dominance in home entertainment.

Video Recording — Recording and Playing Pictures Instantly
For the expanding television industry of the 1950's, live production TV shows had many drawbacks. Top on the list was the problem of dealing with a host of mistakes, errors or technical failures that could occur during a live show. While many of the actors then may have enjoyed the adrenaline rush they got from acting in front of millions of people, TV and advertising executives were not so enthralled.

The solution to that and all the other problems live TV created (including having to broadcast across four time zones in the U.S.) became apparent in 1956, when American Ampex Corporation introduced its innovative rotating recording heads. This unique technology helped solve one of the main problems of recording video on magnetic tape.

While modern science had previously solved the problem of recording audio on magnetic tape, video presented another problem. That's because to get an acceptable image on tape requires more than 200 times the amount of information needed to record sound. Researchers in the early 1950's knew two partial solutions to the video problem: speed up the tape or increase the number of recording heads.

The Ampex video recorder used four video heads rotating on a drum at 250 revolutions per second. When that was combined with two-inch magnetic tape that moved at 15 inches per second, the resulting head/tape speed was much more capable of capturing and recording the information needed to reproduce a video image.

Today's home VCRs, direct offshoots of the bulky, professional video recorders first introduced for television54 production by Ampex and those first produced for the home by Philips in 1972, are at once simpler and more sophisticated than their predecessors. A fast revolving record/playback head is mounted at a predetermined angle to the tape that is passing by it. Each revolution of the head records all the information of a single image across the width of the tape in a zigzag track (that is, one diagonal track for each frame of a picture).

During the recording process, before arriving at the record/playback head, the tape passes by the erase head, which eliminates any previously recorded magnetic patterns on the tape. Two linear tracks on either side of the diagonal video tracks are also recorded on the tape at the same time the video images are being recorded. One is the audio signal track. The other is the synchronization signal which controls the pictures themselves.

VCRs — Viewers Take Control of Their TVs

While this technology has become almost commonplace, its impact on the entertainment industry and the viewing public is still being felt in a variety of ways. The sheer number of VCRs and the meteoric rise in their sales since they were first introduced in 1972 is astounding.

In 1978, only 400,000 VCRs could be found in the United States. Yet, just 6 years later, more than 8 million were sold in one year alone. By 1985, 20 percent of American homes had a VCR. That figure jumped to 75 percent by 1990 and to 85 percent by 1995. It's not an exaggeration to say the VCR has become a member of the modern family in the United States.

The VCR has fundamentally changed the way Americans view television. "The age of personal choice television," as media observer William J. Donnelly calls it, got its start with the widespread use of VCRs. No longer slaves to their *TV Guides* and network or cable schedules, Americans now enjoy the freedom of recording their favorite shows and viewing them at their leisure with VCRs. As a result, they've also gotten used to being able to zap by commercials, much to the chagrin of advertisers.

But resilient advertising professionals and their clients have taken this apparent negative and turned it into a distinct positive. Using the tried and true "if-you-can't-lick-'em, join-'em" logic, marketing types have turned the VCR/videocassette phenomenon into another powerful selling tool. In fact, the sheer number of VCRs in the U.S. has created a huge marketing avenue for customized videos.

In 1988, marketers distributed 5 million videocassettes. By 1994, that figure had increased to 60 million. It's expected to climb to 85 million by the end of 1995. The key is that videos are still seen as a novelty by the public, and as such, are rarely tossed out with typical print "junk mail." In fact, because the cost of video duplication has plummeted, promotional videos are often more cost efficient than printed materials.

America's insatiable appetite for entertainment and the presence of VCRs in the vast majority of homes has also created a massive video movie rental and sales industry with annual revenues in the billions of dollars. In fact, many industry analysts suggested a strong correlation between the rapid rise in popularity of renting and buying videocassettes during the 1980's and 1990's and the considerable drop in broadcast television's share of prime time audiences during the same period (from more than 90 percent in 1978 to less than 70 percent in 1990).

VCRs and an Uncertain Future

Despite the proliferation of VCRs in homes and video stores on what seems like every corner in America, there is something new on the horizon. A new video format, Digital Video Discs (DVD), is due to be unveiled in early 1996. Media observers are saying the

DVD picture quality is superior to current videotapes and even better than laserdiscs.

Developed by Toshiba and Time-Warner, DVD is based on current compact disc technology with a surprising variety of features unavailable on VCRs or videocassettes. The disc itself contains 5 gigabytes of storage on each side (an equivalent storage capacity of 15 compact discs or 6,900 floppy disks), which translates to 135 minutes of video per side.

DVD also features a multiple aspect ratio. That means viewers can play the disc in television's standard 4:3 aspect ratio, a letterbox version, or in the wide screen 16:9 aspect ratio of future high-definition television. There's also CD-quality audio and a parental lockout feature to block out objectionable material.

While a similar version of this format was developed by Philips and Sony, the larger-capacity version by Toshiba and Time-Warner is the one that has received the backing of several electronic industry and Hollywood heavyweights. DVD supporters include Matsushita (Panasonic), Hitachi, Pioneer, Thomson (RCA), MGM/UA and MCA. It's estimated the DVD player will be priced at about $500, with pre-recorded discs priced under $25 each.

However, one of the drawbacks to the DVD discs is that, like music CDs, they can't be copied. More importantly, DVD machines cannot record programs, one of the biggest conveniences that VCRs afford.

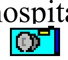
Given that current inability, America's home entertainment centers, at least for the foreseeable future, may have VCRs and DVD systems side-by-side.

u contributed by Michael C. Lafferty

Video Conferencing

The ability to conduct meetings with two or more people at various sites using video that is transmitted by telephone, satellite or computer network.

Video conferencing allows people at various locations to communicate visually with each other and to share documents using video signals sent via telephone lines, satellites or computer networks. For business, the ability to meet face-to-face is often essential. Speaking over the phone just does not provide the same interaction provided when participants can see each other's faces and examine non-verbal cues and gestures. Face-to-face contact also promotes creativity and brainstorming, which help develop ideas and advance projects.

With associates often spread across the city, country, or globe, face-to-face meetings present economical and practical challenges. It is expensive to transport employees to a meeting place and difficult to coordinate schedules. Video conferencing eliminates or reduces these problems while providing the benefits of face-to-face contact. For example, video conferencing has been used to link rural doctors with physicians in metropolitan hospitals. The geographically remote doctor uses a video monitor to examine patients  .

But combining video with voice so people can see as well as speak to others over great distances is nothing new. AT&T unveiled the first video telephone more than 30 years ago at the 1964 New York World's Fair. Unfortunately, video telephones have yet to become commonplace. Although fiber optic cable, advancements in digital compression, increased computer processing power and lower-cost equipment promise to make video conferencing commonplace, it remains expensive, inconvenient and often low-quality. Improvements, however, seem to be close.

Today, there are three ways to conduct a video conference: by using satellite equipment, by using telephone lines, or by using video technology recently developed for desktop computers. Each method has its benefits and drawbacks.

Satellite Conferencing
Many companies, particularly large ones with branch affiliates scattered across the country or globe, need an easy way to connect their individual parts. By leasing satellite time, they are able to do so. Though fairly expensive, satellite transmissions essentially provide broadcast-quality video conferencing ability. Each office that participates in a satellite link-up has video broadcast equipment and a satellite dish to send and receive signals.

Buying video equipment and satellite dishes plus the cost of leasing satellite time (which can cost thousands of dollars for an hour-long conference) makes satellite video conferencing an expensive proposition. When compared to the cost of travel, lodging and meals for the participants if they had to travel to a central location, however, video conferencing can actually save money. Additionally, companies can use satellites to send other information, such as motivational or training videos, press conferences or weekly video sales reports to associates.

The major downside of satellite-transmitted video conferencing is inflexible schedules. Because satellite time must be reserved several days in advance, scheduling spur-of-the-moment meetings is impossible. Also, the time allotted for satellite transmission may be less than it takes to conclude the business of a meeting. Another major drawback is the delay of transmission. It takes about 1/4 of a second for sounds and images to reach their destination. Though this seems like a short time, it can disrupt the communication process.

Telephone Lines

Telephone lines offer an alternative to satellite-based video conferencing. AT&T, for example, markets a video phone designed for residential use that uses standard telephone lines to send and receive video. But the picture's quality is generally dismal, and the nearly static image can hardly be called a video. Video phones are capable of sending a snapshot (a frame) every second or so. By contrast, television broadcasts about 30 "snapshots" every second to simulate natural movement. AT&T's video phone is better suited for residential use than business applications because of its tiny 3-inch diagonal screen and relatively poor picture quality.

Certain types of video conferencing software designed for personal computers that have been equipped with cameras and microphones also use standard telephone lines to send information. These programs can achieve transmission rates of about 8 to 10 frames per second.

The reason for the low frame rates of video conferencing systems using standard phone lines is that these lines can only accommodate a limited amount of information at one time. Video and pictures constitute a lot of information for a plain old telephone service (called POTS by telephone engineers) to handle. For video conferencing needs, devices working on POTS are inadequate.

Fortunately, there are high-speed telephone lines that can handle greater information loads. Most high-speed telephone line systems, much like satellite video conferencing systems, are room-based. This means that they broadcast a group of people sitting in a room, rather than each individual person. Camera operators can zoom in on individuals or presentations or can scan the entire room. Separate cameras can be dedicated to broadcasting written material, such as charts and graphs.

In addition to using phone lines that can accommodate greater amounts of information, a device called a codec (coder-decoder) is used to facilitate transmission of video. A codec is like a computer modem for video information. It digitizes video signals, which means it translates them into a form that computers can understand. This digital video information is then compressed — manipulated so the same video information can be represented with less data. A codec on the receiving end then decompresses the video so it can be displayed on a monitor.

In an effort to bring video conferencing to the public, Kinko's, a national chain of copy shops, together with long-distance provider Sprint, offers video conferencing facilities at many of its locations. The system uses high-speed telephone lines to transmit the video. Starting at around $300 per hour, a two-way video conference can be set up between two

Kinko's locations. For additional per-hour costs, more sites can be patched into the conference.

Though leased telephone line conferencing provides businesses some advantages over satellite-based video conferencing, it still has drawbacks. These lines must be leased from the telephone company, and users pay a flat rate for the lines, regardless of how much they use them. And, like satellite-based video conferencing systems, companies must invest a great deal of money to buy the monitors, cameras and other equipment needed for telephone-based video conferencing systems.

Computer Networking

Computer-based systems have become the latest way to hold video conferences. Associates can establish video link-ups with each other from across the hall or across the country if their computers are equipped with the necessary hardware and software. Such systems are desktop-based and often use telephone lines to transmit information. This means that associates no longer have to gather in one room to conduct a conference. Each can participate from the comfort of his or her desk.

Computers in desktop systems are equipped with cameras, microphones, speakers and special equipment that can handle incoming and outgoing video signals. Some computers are manufactured with this hardware already installed; others allow it to be added later.

Desktop systems process the video image through a computer and send the image and sound through a local area network (LAN), which connects computers located in the same office or a building. Computers not networked through a LAN can share video through leased telephone lines, POTS, or the integrated services digital network (ISDN). ISDN is a relatively new technology that allows high-speed digital transmission through the existing telephone network. Unlike leasing lines, users pay only for the time they actually use ISDN. Phone companies, however, charge a relatively small monthly fee for providing ISDN service. (This monthly fee is a fraction of what leased lines cost: ISDN service may cost $37 per month, while leased lines may cost $2,000 per month.)

Video conferencing from personal computers has the added advantage of allowing various users to share other computer programs and even make on-screen edits. Numerous people can all look at the same spreadsheet or word-processing document and make changes to it instantly.

The key to desktop video conferencing is data compression (also called digital compression). Compressing data is important because, as with telephone wires, even the most advanced desktop computers can only handle a limited amount of data at one time. One way a computer compresses data is by not producing new data for sections of video that remain constant. This saves the computer processing effort. Special software or dedicated microchips are used to compress video data. Because there are different ways to compress data, it is important that one common standard for data compression is used so computers with different software and hardware can still communicate.

Another way a computer reduces the amount of data it takes to run video is by limiting the amount of screen real estate (the area of a screen) the image takes up. A video image that runs at one-sixth the size of the screen takes less computing power than one that runs at full-screen. If many people are participating in a video conference, limiting the screen real estate each person takes up becomes a necessity simply so all the participants can fit on one computer screen.

Even with compressed images, today's most advanced desktop conferencing systems are limited to sending about 15 frames per second, about half of the rate of full motion television images. Desktop video-conferencing systems designed to connect remote users over the standard telephone network can only achieve transmission rates of 8-10 frames per second.

Other problems also exist with desktop conferencing. Some video conferencing software requires separate telephone lines for the audio signal and video signals. Still another disadvantage is the computing power some of these systems require. Many video conferencing systems require expensive, top-of-the-line microchips running at full capacity to handle video.

With advances in video compression and wider deployment of new transmission methods (such as ISDN), many of the limitations of desktop conferencing may be solved. Perhaps desktop conferencing will soon effectively compete with satellite or high-speed telephone wires to deliver high-quality signals.

u contributed by Christopher LaMorte

Videotex

A generic term for the two-way communication that enables a user to receive text on a computer or a television set that is equipped with a decoder and keyboard. Since it is interactive and allows the viewer to communicate with the sender, videotex can be used to retrieve information, compute, conduct transactions, send and receive messages and download or receive computer software programs. Videotex that is transmitted as a separate cable television (CATV) channel over coaxial cable is referred to as *cabletext*.

Videotex systems originated in Europe in the 1970's. France's Minitel system, for example, is a videotex service with over eight million users. Italy, Ireland and Germany also have videotex systems. In 1983 the first integrated videotex network was established in Europe.

In the United States, early videotex services were supported by newspaper publishers; however, these services failed to gain popularity. In 1980, American Telephone & Telegraph (AT&T) and Knight-Ridder, one of the country's largest newspaper publishers, built a telephone-based videotex network in Coral Gables, Florida. But following the 1984 court-ordered breakup of AT&T, both AT&T and the regional Bell operating companies (RBOCs) were prevented from entering into the videotex business. In 1986, Knight-Ridder and Times-Mirror, another large newspaper publisher, abandoned the idea of videotex after the two companies had spent $80 million in a joint attempt to make videotex an electronic newspaper.

Despite the failure of these early videotex services in the United States, the idea of an interactive information service was still feasible. Companies such as Dow-Jones News/Retrieval delivered a service that investors supported. As the personal computer (PC) gained popularity at home and in the office, videotex became a viable service; however, the failure of the early videotex services, and the associated bad publicity, made new service providers shy away from being called videotex.

Currently, videotex services for personal computers are called *on-line* or *interactive* services. Some of the popular on-line services are America Online, Prodigy, CompuServe and GEnie. These services are accessed using telephone lines that connect a PC to a host computer and enable the user to access an exploding array of data bases, libraries, special interest groups, electronic mail (E-mail), catalogs and transactional services (bill paying, product ordering, banking, etc.).

One of the most common pathways to reach videotex and similar services is via the Internet, a telephone network of over 13 million computers worldwide. The Internet provides computer access to videotex, graphics, data bases, games, library services, software, electronic bulletin board services (BBS) and other products and services.

Although early attempts to use videotex to deliver newspapers failed, video or electronic publishing has gained a foothold in the new on-line technology. Newspapers such as *The New York Times* and *Chicago Tribune* have been joined by many national magazines, including *The Smithsonian*, *National Geographic*, *Atlantic Monthly* and *PC Magazine* that can be read using on-line services. In 1995, America Online announced that *Saturday Review*, a magazine that ceased publication in 1986 after 66 years, would be electronically published. In addition to reading the magazine, people would be able to write reviews of articles and engage in live discussions, called chat areas, with editors, politicians and celebrities.

Yet another type of videotex is delivered over cable television lines. For example, XPress and Lotus Signal are two cabletext services that are distributed through CATV systems. XPress is transmitted on a frequency modulated (FM) signal and connected to a PC using a specialized modem. The user has access to text files on news and data bases and can interact with the service using phone lines.

Begun as videotex, an electronic means of distributing the printed word, the new on-line services go well beyond text. Television networks such as ABC now provide video footage of historic news events that can be downloaded to a PC. Downloading transfers the electronic file from the host computer to the PC so users can read or view the item at their convenience. Even at current data transmission rates and using digital compression, downloading video is a lengthy process, and even short video segments can consume considerable storage capacity. In addition to video segments, transcripts of television newscasts are available to on-line subscribers.

In the mid-1990's, videotex services, under the names on-line and interactive services, have surged in popularity on the coattails of the PC and become one of the fastest growing consumer services.

u contributed by Paul Stranahan

Virtual Libraries

Libraries that use electronic networks and computer-based technologies to perform their traditional activities — information organization, storage, retrieval and interlibrary loan — as well as many newer activities, such as electronic document delivery, on-line database searching, and current awareness services. Many of today's libraries combine elements of both yesterday's book-based structure and tomorrow's computerized, networked "cybrary."

Traditional Role of Libraries
The original role of libraries was to be the keepers of the intellectual, cultural, and historical memory for their communities. To accomplish this, libraries would acquire, catalog and make available information. At first this was simply in the form of written text. Later, photographs, artwork, and audio and videotapes were included in these collections. Long known as the people's university, libraries have traditionally provided their services either free or at a nominal fee to everyone, so that no one is denied access to information.

However, contemporary libraries are now faced with an almost overwhelming amount of information that comes in a vast range of media and is increasingly expensive. A traditional library must limit access to any single piece of information to one person at a time, and often that person must physically come to the site of the library.

Computerizing Resources
To begin dealing with some of these problems, libraries began to computerize and automate various services, including circulation (checking books out), cataloging and the card catalog itself. Many have converted paper card catalogs to computer-based on-line public access catalogs (OPACs), which allow several people to use the same database simultaneously through separate terminals (or with some OPACs, by dialing in via a home or office computer). In addition, many of the print-based periodical indexes have been placed in computer databases or on compact discs. With the advent of these computerized resources, many types of information are now available not only to those physically at the library, but also to those using computer terminals in homes, offices and schools.

The traditional method of overcoming storage and access problems for periodicals and newspapers was to preserve back copies on microfilm or microfiche. The introduction of compact disc-read only memory (CD-ROM) technology, however, has revolutionized the storage, access and retrieval of vast amounts of information. Each CD-ROM can store about 250,000 pages of text, 7,000 pictures or 72 minutes of video. This permits full-text reference sources and periodicals to be easily and efficiently stored and retrieved.

Despite the benefits brought about by computerization and advances in storage and retrieval systems, libraries still struggle with the challenge of keeping up with an exponentially increasing volume of information materials. No single library has the space, time or money to acquire and store it all. One of the solutions libraries have devised is multi-library, regional networks that enable all types of libraries (school, special interest, academic, government, corporate and public) to share resources and provide more efficient access to references. In conjunction with the national Online Computer Library Center (OCLC) network, these networks function as key components of the electronic library.

A Changing Environment
The information infrastructure is already dramatically changing for libraries. Information can now be directly acquired in a digitized format. This digitized information can be easily updated, manipulated, combined with other materials, and displayed in multiple ways. Through the Internet and other on-line networks, libraries can now access collections maintained by publishers, research organizations, universities, commercial enterprises, and other players who are just beginning to emerge.

In the meantime, standards must also be developed and agreed upon for access and retrieval processes; computer-to-computer communications; cryptography (to ensure that documents are digitally converted accurately); security; user privacy; and archiving of material. In addition, questions must be answered concerning how much archived material will be converted or whether only relatively recent material will be converted; what information should be locally loaded in an OPAC and what should be on CD-ROM; who will do the conversion; and who will pay for it.

In addition, several groups are attempting to deal with the thorny issues of copyright protection and the broader area of intellectual property rights. A copyright standard set in the United States may be much different than one set in France, for example. With worldwide access not only possible, but probable, these issues must be dealt with. In addition, if libraries must charge for access to documents because of copyright laws, then how do they preserve the right of universal access to the same information? These issues are currently being dealt with by representatives from the government, industry, academia, publishing, and the libraries.

Transition to Virtual Libraries
Many universities and colleges are in the forefront of creating virtual libraries. Colorado State University, for example, has used a three-phase approach to its electronic library. In phase one, basic E-mail was established to accept requests for items from the library. In phase two, a link to CD-ROM products was mounted on the library's local access network. Phase three included an additional program with the ability to capture screens from any dial-up database and mail the file to an E-mail account.

Another example is Project Janus, which uses a massive supercomputer to provide users of Columbia University's law library with access to texts, graphics, sound, and video from remote and local work stations. The supercomputer, which was installed in 1992, was initially intended to help solve the library's need for space by electronically storing special collections, reference materials and other works. In 1993, Columbia expanded the on-line library university-wide. Janus uses optical character recognition (OCR) technology for scanning in information and searching via digitized photographs of pages. Although this technology requires a vast amount of computer memory and has a 5 percent error factor, it also allows users to speak to the system in "natural language," which permits browsing of documents.

Many corporations, with their smaller specialized libraries, are uniquely positioned for moving into virtual libraries. Several already have computer networks throughout their businesses, and many of their employees are comfortable using computers for information access. U S WEST, for instance, developed its Electronic Library to help manage the huge costs incurred from the dissemination of paper copies of technical and administrative documents. The U S WEST system, called Document Management Platform (DMP), stores and retrieves documents that employees can access through desktop terminals. The Electronic Library, which initially focused on internal documents, was developed after the company looked at exactly what employees needed in the way of on-line access. A second phase of the library will explore more cost-and time-effective ways to secure externally-created information that the company may be currently purchasing multiple times. Examples include journals, newspapers or market research reports. Like everyone else dealing with virtual libraries, corporations must solve the problems of pricing and copyright compliance on external materials.

The Human Element

Although the technology of virtual libraries and information dissemination is of key importance, the human element cannot be ignored. The role of the librarian changes in many significant ways, but remains the same in many others. Librarians must still select, evaluate and organize material, even though it may be stored electronically rather than on paper. And patrons will need their guidance now more than ever, whether it's on how to evaluate information resources, how to operate the hardware, how to use the software, or how to most effectively navigate the information highway.

Many individuals are anxiously (others eagerly) awaiting the virtual library. Accessing information through their home or business computers may be "old hat" to some, while others still haven't mastered the microfiche machine. For the latter, the thought of being able to find material only through a computer is terrifying. Nevertheless, large university libraries, special libraries (for example, legal or medical), public libraries in major cities, and corporate libraries are making the transition and are bringing their patrons along. Smaller libraries will probably follow suit as funding, expertise, and patron willingness increase.

Summary

Users of libraries (whether public, academic, school, corporate or specialized) increasingly demand more information, delivered more quickly, and in a more efficient package. The virtual library in its various forms is an effective architecture through which to meet this need. Before virtual libraries can become commonplace, however, decisions must be made about copyright considerations, pricing of electronic documents, access and presentation standards, and international implications. In the meantime, the general public is gradually becoming used to the idea of using computer terminals to access certain types of information at the public library, while academic and corporate libraries are quickly changing many aspects of their service to digitized, electronic versions. Throughout this transition to electronically-mediated materials, librarians will continue to champion the goal of universal, affordable access to the world of information that surrounds us.

u contributed by Linda Stranahan

Virtual Reality

Virtual reality systems use computers to create simulated environments that can be entered and interacted with by using special equipment such as goggles and data gloves.

Virtual reality (VR) is one of the hottest research and development areas in the computer industry today. Its potential applications range from medical imaging and interior design to intercontinental videoconferencing and the exploration of future worlds. There are a number of ways in which virtual reality technology can be employed; its underlying premise, however, is to create more intuitive ways for humans and computers to work together.

VR is often thought of as new technology, but its development actually dates back almost 50 years to flight simulators built by the aircraft industry and the U.S. Air Force during and after World War II. Student pilots learned how to maneuver airplanes by manipulating the controls in specially built airplane cockpits. These cockpits, which were actually removed from the airplanes themselves, were mounted on movable platforms that tilted and rolled based on the pilot's actions on the controls.

VR's future was also influenced by film techniques such as stereoscopic, or 3-D cinema, and several wide-screen systems that Hollywood filmmakers were experimenting with during the early 1950's. Cinerama, the best-known of these technologies, sought to expand the movie-going experience by filling a larger portion of the audience's visual field. Three cameras, shooting from slightly different angles, were used to film each scene in a Cinerama movie. The film was then synchronized and projected onto three large screens that curved inward, wrapping around the audience's peripheral visual field. This technology proved too costly to be embraced by most commercial theaters, but the theory of visual immersion would go on to become an important VR element.

Cinerama excited a young documentary filmmaker named Morton Heilig, who believed the future of cinema lay in creating films that could employ the human senses of sight, sound, scent, and feel. He diagrammed the various elements he felt were necessary to create that total illusion, such as the brain's sensory channels and the body's motor network. He called his end product "experience theater."

Heilig's research led to "Sensorama," a VR-type arcade attraction he designed and patented in 1962. Sensorama simulated all the sensory experiences of a motorcycle ride by combining 3-D movies, stereo sound, wind, and aromas. By gripping the handlebars on a specially equipped motorcycle seat and wearing a binocular-like viewer, the "passenger" could travel through scenes including California sand dunes and Brooklyn streets. Small grills near the viewer's nose and ears emitted breezes and authentic aromas. Sensorama was extremely complex for the arcade environment, and funding never materialized for the simplified version Heilig later developed, but his vision of a medium that combined multisensory artificial experiences is fast becoming a reality.

Cinerama and Sensorama gave VR two of its most important theoretical and visual legacies, but artificial intelligence research conducted in the late 1950's and 1960's largely formed the scientific platform for VR as it exists today.

One area of artificial intelligence research explored building better interfaces between people and machines. In the early 1960's a graduate student named Ivan Sutherland presented a Ph.D. thesis in this area that demonstrated a new way to interact with computers. Sutherland believed that display screens and digital computers could offer a means of gaining familiarity with concepts not realizable in the physical world by providing a window, or looking glass of sorts, into the mathematical wonderland of a computer.

Sketchpad, the program Sutherland developed and described in his thesis, used computer technology to create images from abstract ideas. Using Sketchpad and a penlike device, a computer could create sophisticated images on a display screen resembling a television set. The system responded by rapidly updating the drawing so that the relationship between the user's action and the graphical display was clear. Computer-aided design (CAD) grew out of Sutherland's thesis and became one of the most powerful components of VR development in the 1990's.

Sutherland next focused on developing technology that would allow computer users to actually enter the world of computer-generated graphics. In 1965, with support from the Department of Defense's Advance Research Projects Agency (ARPA) and the Office of Naval Research, Sutherland unveiled the head-mounted display (HMD), which took users inside a three-dimensional world by limiting visual contact to the displays shown by small computer screens mounted in binocular glasses. It became a cornerstone of VR technology.

In the late 1960's and 1970's, research on a number of fronts formed the basis of VR as it appears today. Projects such as the Aspen Movie Map, developed by a group of researchers including Andrew Lippman, Michael Naimark and Scott Fisher at the Massachusetts Institute of Technology (MIT), showed video images of Aspen, Colorado, that visitors could actually navigate by indicating their choices on a touch-sensitive display screen. Videoplace, one of several experimental artistic environments designed by arts scholar Myron Krueger, used computers to create what Krueger called "artificial reality," allowing viewers to interact with computer-generated graphics and projected images.

In the mid-1980's, the different technologies that enabled the development of VR converged to create the first true VR system. Researchers at NASA's Ames Research Center in Mountain View, California, were charged with creating an affordable pilot training system for manned space missions. Over several years, the project pooled the resources of such individuals as Scott Fisher, who had continued his research on virtual environments after the Aspen Movie Map project; Stephen Ellis, a University of California-Berkeley researcher who had studied how human beings interact with their environments; Michael McGreevy, a UCB graduate student who was also interested in immersive displays; and Warren Robinett, a programmer who had worked on educational software at Atari.

The conjoining of their efforts, as well as the contributions of other researchers and companies, led to the development of the Virtual Interface Environment Workstation. It was the first system that combined such standard VR elements as computer graphics and video imaging, 3-D sound, voice recognition and synthesis, and a head-mounted display. A data glove, based on an invention designed to play air guitar, completed the system.

From there, it was only a matter of time before VR programs began appearing in settings ranging from virtual reality theme parks to operating rooms, largely aided by products developed by Jaron Lanier, whose programming language operated the first data glove at the NASA research center. Lanier's company, VPL Research, was the first company to focus its efforts on developing products for the infant VR industry, and provided the headgear and gloves used in many early VR applications.

Head-tracking helmets and data gloves, wired to a specially programmed computer system, provide the traditional entry into virtual worlds. Most head-tracking displays resemble helmets, from which viewing devices are displayed. Datagloves contain flexible fiber optic wires that run along the length of each finger, which sense the movement and position of hand. Special devices called trackers are attached to this equipment. They translate movements into coordinates, which are then fed back to the computer so that the model of the virtual world can be appropriately changed.

It is also possible to experience virtual worlds without using immersion devices. New technology such as The PHANToM, developed at the MIT Artificial Intelligence Lab, creates the illusion of touching virtual objects. Projected systems, often used in museums and for medical displays, take an image of the user's motions and display it with other images on a large screen. Simulation VR, widely found in VR game arcades and parks, use a combination of video monitors and movable pods or platforms to create virtual experiences. The Magic Edge, for example, a combination restaurant/bar in Mountain View, California, offers virtual reality flight simulators that let would-be fighter pilots battle each other over a fully rendered virtual landscape. It is even possible to enter virtual worlds through a desktop computer, although the high cost of the equipment involved makes it difficult to create a truly immersive VR event.

In 1984, science fiction writer William Gibson coined the term "cyberspace," which described a future world created by the networking of multiple VR systems and environments. As computer systems get faster, less expensive and more powerful, virtual reality systems will do so as well and will increasingly become a part of everyday life. The world that Gibson imagined will be more than just a writer's dream.

u contributed by Sonia Weiss

von Neumann, John (Johann) (1903 – 1957)

Hungarian-born American mathematician, known for developing the branch of mathematics called "game theory" and for his contributions in the field of computers, including the stored-program concept.

Born in Budapest, Hungary in 1903, von Neumann was educated at the universities of Berlin and Budapest, receiving his doctorate in mathematics from the latter in 1926. While continuing his work in quantum physics and operator theory, he gave academic lectures in Europe until 1930. Von Neumann immigrated to the United States and joined Princeton University's full-time faculty in 1931. He became a lifelong professor at Princeton's new Institute for Advanced Study in 1933, and a naturalized American citizen in 1937.

From 1935 to 1940, he developed his theories on "rings of operators" also known now as "Neumann algebras," in collaboration with F. J. Murray. Used in the study of quantum physics today, this work is considered some of von Neumann's most brilliant and enduring.

During World War II, von Neumann consulted on the Los Alamos project's successful construction of the first atomic bomb. He supported the use of implosion to cause nuclear fuel to explode.

In 1944, he co-authored the *Theory of Games and Economic Behavior* — which elaborates on his "minimax theory" first advanced in 1928 — with German-American economist Oskar Morgenstern. Applicable to games of chance and skill, their theory plays a major role in mathematical economics and operational research.

In 1946, von Neumann published a paper on the stored-program concept for computers, a then-revolutionary idea that's still associated with him. At the time, computer programs were separate from the machine and required much effort and many man-hours to be changed. But a stored-program could be kept in the machine's memory just like data, and accessed and changed just as easily. When the first stored-program computer ever conceived was being constructed by J. Presper Eckert and John Mauchly at the University of Pennsylvania's Moore School, von Neumann was on the team. The EDVAC was completed by others, however, after Eckert and Mauchly left the Moore School.

In the mid-1950's, von Neumann became a member of the U.S. Atomic Energy Commission (AEC), an organization that gave him the Enrico Fermi Award in 1956 for outstanding contributions in the field of electronic computers.

For the last 40 years, computer architecture has been influenced by von Neumann's theories. He is also considered one of history's outstanding mathematicians for his contributions to the theory of quantum mechanics and applied mathematics. John von Neumann died in 1957 in Washington, D.C., at age 54, shortly before his scheduled lecture at Yale on the possibility of artificial intelligence.

u contributed by Kay S. Volkema

Warner Brothers Television Network (WB)

Warner Brothers is a name associated with old Hollywood and timeless cartoons. In 1995 the new Warner Brothers Television Network (WB) became America's official fifth national network. Although WB is not a true network by Federal Communications Commission (FCC) standards, the company has strong leaders and a plan for success. Warner Brothers is headquartered in Burbank, California.

During the Nixon, Ford, Carter and Reagan presidential years, the FCC's role was restructured to respond to the fast-paced changes facing the broadcast industry. One of the notable changes was an expansion in the number of stations receiving licenses. These new stations were mostly unaffiliated. Undoubtedly these stations would have been more profitable with a network affiliation, but there were few openings with the established three networks (ABC, CBS, and 316) available.

Another big change in the regulatory climate was the weakening of the "fin-syn rules." In 1970 the FCC adopted the financial interest and syndication rules (fin-syn rules), which stated that a network could have limited financial benefit from the production of a show that it aired and could not profit from the domestic syndication of one that it originally aired. This basically meant that a legitimate network could not own or be part of a film or television production house that would have allowed it to cut costs by producing in-house and then reaping additional profits from syndication. What the fin-syn rules did do was to provide an income source for some of Hollywood's production houses. Most of these companies profited heavily from sales to the networks. None of them would want to give up that natural profit center to become a "buyer" or a network.

Yet that is exactly what Fox Broadcasting Company (Fox) did. Fortunately for Fox, Warner Brothers, Paramount and anyone else wishing to enter the network business, the FCC began to lessen the severity and lift the restrictions of the fin-syn rules. A major definition of a legitimate network is that it broadcast at least 15 prime-time hours per week. As Fox edged closer to that definition, the FCC, with the new stations it licensed and its new regulations and rules, made the possibility of new networks a reality. In fact, from 1988 to 1995, the FCC took the steps to lessen and then eliminate the fin-syn rules entirely.

In late 1989 Fox had two prime-time years under its belt and the rumors about a fifth network started. In late 1993 Paramount announced it would start a new network and a week later, Warner Brothers made the same announcement. Paramount's network was to be called United Paramount Network, or UPN. Both networks indicated they would go on the air during the 1994-1995 season. Both started seriously looking for desirable independent stations in the best markets to sign on their respective networks. Warner Brothers was not interested in a split affiliation, which involved sharing network programming. But both were anxious to get started. Critics said that even if there was room for another network, there was room for only one more, not two.

Warner Brothers is different from the other television networks because it doesn't own any television outlets. So rather than compensate or *pay* stations for carrying programming, which was the tradition started in the mid 1920's with radio, Warner Brothers announced it would *charge* for its programming. Warner realized it would need a strong person on board in order to sell this to potential affiliates. In 1993 Jamie Kellner, former President of Fox, was hired by Warner Brothers to interest advertisers and agencies in the new network. (In fact, Warner Brothers and Kellner formally joined together in the new network and it is, officially, a joint venture between the two.) Kellner had been at Fox at the beginning of "fourth network" talks, and he brought invaluable experience to this new start-up network. Kellner was named the CEO of the Warner Brothers Television Network, and by late 1993 Warner was on its way with numerous station groups formally committing to the network.

In May of 1994, Fox announced its investment in New World Communications Group, 12 affiliated stations in large markets, and a network domino effect was felt in 23 metropolitan areas in the United States. Stations all over the country switched affiliation. CBS, the hardest hit network, lost eight affiliates. Other stations lost their Fox affiliation because the New World station in that market automatically switched to Fox. Many station owners were faced with an alphabet soup of network choices.

WB's distribution plan was something called "in-pattern" or "a hybrid of broadcast and cable," according to Kellner. As stated in the network's press kit, in addition to the station groups that had already signed up, Tribune Broadcasting with all of its stations including the superstation, WGN, would help the new network reach 210 of the 211 areas of dominant influence (ADI) across the country. When Fox Broadcasting Company went on the air in 1986 with *The Late Show Starring Joan Rivers,* it reached 95 stations. WB's plan, by comparison, was much more ambitious.

By January 1995, most of the dust had settled and Warner Brothers was ready to hit the airwaves. In the unofficial race to be America's fifth national broadcast network, WB beat UPN by five days. UPN premiered its prime-time line-up on January 16, 1995. But WB had already hit the airwaves on January 11. In addition to Kellner, a number of others previously with Fox went to WB, such as the producers of *Married…With Children* and Shawn and Marlon Wayans from *In Living Color.* Like Fox, WB planned two prime-time hours on one night of each week until its foundation was set and expansion could take place. Summer and fall expansion plans were already waiting in the wings.

Two months into the life of the new WB, the outlook was somewhat grim. Not only were the ratings poor, the nation's television critics has little positive to say with regards to the network line-up. But the energetic folks at WB, cheered on by their trademark cartoon frog, were optimistic and persevered.

A frog as a corporate representative? In a word, yes. In 1955 a Warner Brothers cartoon, *One Froggy Evening,* featured a frog named Michigan J. Frog. This same Michigan was chosen to be the mascot and "spokes-frog" for the new television network. He was also chosen to be featured with the 1995 summer release of *Batman Forever,* Warner Brothers studio's third feature film in the Batman series. Michigan's duties, leaping between the studio and television network, would not only keep him busy, but hopefully would also establish a connection in the minds of viewers. Using this same energetic creativity, the plan for the network is to build and grow, to use cable coverage to gain more broadcast coverage, and to add programming one night or segment at a time.

u contributed by Michele Messenger

Kellner, James C. "Jamie" (1947 –)

American businessman and television executive, currently the managing partner of the Warner Brothers Television Network (WB), the joint venture he and Warner Brothers studio started in 1993. By the time WB went on the air in 1995, Kellner had already had a fascinating career in television broadcasting, yet wasn't even 50 years old.

Kellner was born in Brooklyn, New York, and raised on Long Island. His father's occupation as a Wall Street commodities broker provided an up-and-down existence for the Kellner family, and a fitting upbringing for a future television executive.

In the late 1960's, Kellner started off in the working world as a teacher, but eventually returned to school to study marketing. A part-time college job (night manager at a private yacht club) led to his first television job. A patron of the club was impressed with Kellner's abilities. This man, who became Kellner's benefactor, was a CBS employee and offered Kellner a job in the CBS management trainee program.

On the manager-to-be track, Kellner showed promise and ingenuity. When the three established networks were forced out of the syndication business in the early 1970's, CBS set up the new, independent Viacom Enterprises. Kellner moved to Viacom, which led to a job with Filmways, another syndicator that was subsequently taken over by Orion in 1982.

When Rupert Murdoch announced in January 1986, that he was planning to start a fourth television network, it had no name, no concept, and no time frame. But when Kellner was hired four weeks later, it at least had a President.

From 1986 to 1993 Kellner was the President of the new Fox Broadcasting Company (Fox). He survived Fox's affiliate growth as well as programming, sales and marketing challenges. Kellner is credited with launching the Fox Children's Network along with its strategy, sales and marketing tactics. Most importantly, Kellner survived the tension and stress inherent in nearly every start-up business. Kellner not only survived, but decided to do it again.

In the early 1990's, as the Federal Communications Commission's (FCC) relaxed its financial and syndication rules to allow for new networks funded by production studios, Warner Brothers and Kellner started their new venture. Kellner's first responsibility was to acquire affiliates and advertisers. By late 1994 as the final touches were being put on the network's single, two-hour night of programming, Kellner announced that his network had sold all of the available air time at less than Fox's rates, but higher than syndication rates. It was an excellent start for Kellner and WB. But at the two-month anniversary for WB, the critics were not terribly kind. Many predicted that although there might be room for one more network, there was certainly not room for two. And yet two there soon were.

A joint venture between Paramount Communications and Chris-Craft Industries fostered United Paramount Network (UPN), which premiered just five days after WB. Many critics and industry insiders stated that UPN had a better chance at survival than WB. What those critics might have forgotten was Kellner, his Fox experiences, and his upbringing. The competition has just begun.

For now Jamie Kellner stands by his unwavering position that if he produces the right show, the audience and advertiser will find it. It’s what keeps him going.

u contributed by Michele Messenger

Washburn, Abbott M. (1915 –   )

(Pictured, Richard Nixon and Abbott Washburn)

American corporate executive, government official and former Federal Communications Commission (FCC) commissioner with a special interest in television programming for children; also involved in the development of satellite communications and the cellular telephone industry.

Abbott M. Washburn was born March 1, 1915, in Duluth, Minnesota. In the 1940's, he was Director, Department of Public Services, General Mills, Inc. From 1950 to 1951, Washburn was the Executive Vice-Chairman of Crusade for Freedom (Radio Free Europe). Washburn was a member of the Dwight D. Eisenhower campaign staff in 1952. After a year on the White House staff, in 1953 he was appointed Deputy Director of the United States Information Agency.

In 1962, he was President of Washburn, Stringer Associates, Inc., a Washington, D.C., international public affairs consulting firm. He served in that capacity until 1968. He was named Deputy Chairman of the U.S. delegation to the global satellite system INTELSAT Conference in 1969. From 1970-71, Washburn was Chairman of the INTELSAT Negotiating Conference with the personal rank of Ambassador; 89 countries reached agreement on Definitive Arrangements in May of 1971.

In 1974, President Richard M. Nixon appointed Washburn a commissioner to the FCC for a one-year interim term in a Republican seat. President Ford then appointed him to a full seven-year term. While at the Commission took a particular interest in children's television. He and his Legal Assistant, Nancy B. Carey, wrote the Order upon Reconsideration which officially approved the commercial application and use of cellular telephone technology.

In 1976, as FCC commissioner, Washburn testified before the House's Telecommunications Subcommittee during their effort to rewrite the Communications Act of 1934. During his testimony, Washburn presented information about the feasibility of smaller satellite dishes and recommended their wide use.

After leaving the Commission in 1982, he was appointed the Ambassador to the International Telecommunication Union Radio Conference on direct-satellite broadcasting in the Western Hemisphere.

From 1984 until 1989, Washburn was a consultant on communications to the U.S. State Department. Since 1989, he has been speaking and writing on issues related to communications, technology and satellites.

u contributed by Diana L. Hollenbeck

Watson, Thomas Augustus (1854 – 1934)

American telephone pioneer and technician, primarily known for helping Alexander Graham Bell to invent the telephone.

Watson was born in Salem, Massachusetts, in 1854 and received formal schooling to age 14. He met Alexander Graham Bell while working in a Boston electrical shop and they decided to join forces in 1874.

Watson's expertise was in electricity and Bell's was in acoustics. Financially supported by the fathers of two of Bell's deaf pupils, they devoted long nights to developing an apparatus for transmitting sound by electricity, while continuing their necessary day jobs. The work paid off, and on March 7, 1876, Bell received a patent for the telephone. Three days later in Boston, he uttered these historic first words via their invention, "Mr. Watson, come here; I want you." The next year, Watson helped found Bell Telephone Company, where he directed research and technical development until 1881.

After departing Bell, Watson and a partner started a new business building engines and seagoing vessels, including U.S. Navy warships. He retired from this venture in 1904.

Eleven years later in San Francisco, Watson received the very first transcontinental telephone call from his friend Alexander Graham Bell in New York.

Thomas A. Watson, one of telephony's founding fathers, died in 1934 on Passagrille Key, Florida at the age of 80.

u contributed by Kay S. Volkema

Watson, Thomas John, Sr. (1874 – 1956)

American industrialist and businessman, primarily known for aggressively building International Business Machines Corporation (IBM) into one of the world's largest and most powerful companies.

In 1874, Watson was born in Campbell, New York. He was educated at the Elmira (New York) School of Commerce. After holding several minor sales jobs, he was hired as a salesman at the National Cash Register Company in Dayton, Ohio, in 1895. Mentored by the company's president, Watson eventually attained the job of General Sales Manager which he held until 1913.

In 1914, Watson assumed the presidency of the Computing-Tabulating-Recording Company, a manufacturer of electrical punch-card computing systems and other products. Employing 235 people, this company's predecessor was owned by Herman Hollerith, successful American inventor of a tabulating machine that used punch cards. (Hollerith's innovative machine was instrumental in the development of today's digital computer.)

With confidence and daring, Watson (now CEO) changed the name of the company in 1924 to International Business Machines Corporation (IBM). He ran the company until 1952, when his son, Thomas J. Watson, Jr., took over. The senior Watson was Chairman from 1952 until his death in 1956 in New York City.

Over four decades, the aggressive leadership of Thomas Watson, Sr. helped make IBM the world leader in the business machines industry. He focused on his sales staff, keeping them motivated, well trained, well paid and appropriately dressed. He also instituted a research and development program and pursued international trade.

When Thomas J. Watson, Sr. died in 1956, IBM employed 60,000 people in 200 offices. Although he was noted for his involvement in the arts, civic affairs, and promoting world peace, Watson will always be remembered for building IBM into an international powerhouse.

u contributed by Kay S. Volkema

Whitehead, Clay T. (1938 –   )

American engineer and entrepreneur, currently President of Clay Whitehead Associates, an investment and business development firm specializing in telecommunications, and President of National Exchange Satellite, Inc., which is developing a satellite system for business communications.

The Kansas-born and -raised Whitehead received his BS and MS degrees in 1960 and 1961, both in electrical engineering, and his Ph.D. in Management, all from Massachusetts Institute of Technology (MIT). After graduation and until 1968, he served two years in the U.S. Army and, was a defense policy analyst and economist at the Rand Corporation.

In 1970, President Richard Nixon set up the Office of Telecommunications Policy (OTP) as part of the federal executive branch. Rand researcher Whitehead was named to head the OTP. It quickly became clear that, while OTP would provide needed long-range policy planning and research using the facilities of the Office of Telecommunications in the Department of Commerce, its function was actually more political than technical.

The controversy started in 1972 when, in a speech on December 15, Whitehead criticized television stations for relying too much on network programs. Calling network news "intellectual plugola," he implied that stations that failed to correct the perceived liberal bias of the networks with their own programming might have difficulties at license-renewal time. His speech also contained a "carrot." He promised that if stations followed his advice, his office would work to increase the license period from three to five years.

Before that speech, Whitehead had tried to reduce the influence of the public television network, PBS, which he also considered to be excessively liberal. In a speech delivered on October 9, 1971, he urged the National Association of Education Broadcasters (NAEB) to restore control of public broadcasting to local stations, which he saw as more conservative than the networks. The "carrot" in that instance was the promise that if the change he was advocating took place, he would work to increase government appropriations for public broadcasting.

The OTP's first major coup was engineering a compromise between the National Association of Broadcasters (NAB) and the National Cable Television Association (NCTA) in fall 1971 that led to the 1972 Federal Communications Commission (FCC) cable rules. Soon the OTP was involved in seeking five-year license terms for broadcasters, a major broadcasting goal for most of the Nixon administration. Out of the administration's concern for unemployment in the West Coast entertainment production unions, OTP sought to limit program reruns. OTP was also involved in seeking financing for public broadcasting and limiting the scope of the Fairness Doctrine.

After the demise of the Nixon administration in 1974, OTP almost dropped from sight and Whitehead resigned. In 1978, President Jimmy Carter replaced the OTP with the National Telecommunications and Information Administration (NTIA), which he placed in the Department of Commerce. This agency advises the president about telecommunications policy, explores new telecommunications technologies and uses, represents the president in appearances before Congress and other government agencies, and disburses the funds allocated to public broadcasters.

Married with two children, Whitehead was President of Hughes Communications, Inc., a subsidiary of Hughes Aircraft Company, from 1979 to 1983. He led the establishment, financing, marketing and operations of the Galaxy and Leasat satellite systems that are used for telephone, television and defense communications. Since 1988, Whitehead has been the President of Clay Whitehead Associates, a McLean, Virginia, investment and business development firm specializing in telecommunications. He is also President of National Exchange Satellite, Inc., which is developing a satellite system for business communications.

u contributed by Diana L. Hollenbeck

Wireless Technologies: History and Development

Conceptualized in the late 1800's, wireless technology made its commercial debut with telegraphy. By the 1970's, it had evolved into mobile radio, broadcast radio, television, private-line microwave voice and data transmission, and satellite communications. Since then, development and use of wireless applications have exploded. Among current services are paging, packet radio, cellular mobile telephone, direct broadcast satellite (DBS), and local area wireless networks. Analysts predict personal communications services (PCS) and global satellite networks will penetrate the marketplace with voice, data, and facsimile transmission offerings by the turn of this century.

Currently the industry is going through growing pains as companies quickly update existing products and services and release new ones. Devices for wireless transmissions are becoming increasingly mobile and compact. As wireless competition intensifies and the number of services increase but also differ in their offerings, consumer confusion will mount. At the same time, however, prices should decrease.

Between 1995 and 2000, the dynamic wireless network market is expected to grow ten-fold.

The Early Years
In the 1860's, Scottish physicist James Clerk Maxwell catalyzed development of wireless technology when he theorized the existence of electromagnetic waves. Based on Maxwell's theory, German physicist Heinrich Hertz conducted experiments that proved that electromagnetic radiation, or radio waves, not only did exist, but also could be used for communications. When English physics professor Oliver Lodge expanded on Hertz's experiments, he discovered that the resonant properties of electrical circuits could be used both to produce and detect waves of a certain frequency. This sequence of discoveries laid the groundwork for development of wireless telegraphy.

Envisioning the commercial potential of wireless technology, Guglielmo Marconi focused on developing a practical wireless system for ship-to-shore communications. After the turn of the century, Lloyds of London began leasing Marconi's services and equipment to relay shipping information. In 1919, Radio Corporation of America (RCA), a subsidiary of General Electric, bought a controlling interest in American Marconi and exclusive rights to send wireless messages into the Marconi international network.

To regulate wireless communications at sea, in 1912 the United States Congress passed the Radio Ship Act, which licensed maritime stations and operators. Subsequently, Congress created the Federal Radio Commission and its successor, the Federal Communications Commission (FCC), to assign radio frequencies, determine standards and oversee regulations.

The wireless telegraph's potential capabilities served as incentive for other inventors to strive to improve Marconi's system. From their discoveries and inventions, the capability to broadcast the human voice evolved. In November 1920, KDKA in Pittsburgh, Pennsylvania, became the first commercial radio station . Within 18 months after its first broadcast, another 220 stations were on the air. By 1927, 7.5 million radio sets had been sold in the United States.

Next, images began riding the electromagnetic waves. RCA began regular television broadcasting during the New York World's Fair in 1939. During the late 1940's, commercial television took off.

In addition, the first commercial microwave radio link began operation between Philadelphia and New York City. American Telephone & Telegraph (AT&T) completed the first transcontinental microwave relay system in 1951. Within a decade, microwave relay towers became a common sight. In the 1960's, Microwave Communications, Incorporated (MCI) established private line, point-to-point, microwave voice and data transmission. The company provided both local and intercity service.

Manmade Satellites Beam Communications

After commercial broadcast radio and television became widespread, the next major development in wireless technology was the use of manmade satellites for communication. For more than a decade before the first experimental communication satellite was launched, scientists researched the potential communications capabilities of satellites. In 1945, Arthur C. Clarke, a British author and scientist, envisioned manned geosynchronous satellites: stationed about 22,300 miles above Earth, three satellite stations equipped with directional antennas, receivers and transmitters would receive and beam radio signals to Earth. Ten years later, J.R. Pierce, a U.S. engineer and scientist, published a paper that proposed unmanned communication satellites and analyzed the effects of altitude, orientation, and the earth's gravity on controlling a satellite's position.

In December 1958, the U.S. government project SCORE (Signal Communication by Orbiting Relay Equipment) launched an experimental battery-operated satellite into elliptical orbit. When in delayed-repeater mode, it recorded messages on magnetic tape and then retransmitted them to Earth. A succession of ensuing communication experiments successfully transmitted voice, data, and facsimile messages. Telstar, which AT&T launched in 1962, transmitted live television and telephone conversations across the Atlantic Ocean. Two years later, Syncom 3 relayed televised broadcasts of the opening ceremonies of the Olympic Games in Tokyo, Japan, to the west coast of the United States.

With the growth of international communications by satellite came the need for a global system. In 1964, 11 countries organized an international legal entity called INTELSAT, in which COMSAT is the United States' designated participant.

With the 1965 launch of INTELSAT I, satellite communications changed from an experimental to a commercial enterprise. (Another international group, International Maritime Satellite Organization [INMARISAT], handles ship-to-shore communications.)

The development of powerful boosters for launching heavier satellites, improved methods for altitude control and stabilization, and echo suppression technology significantly enhanced satellite communications. By the 1980's, the INTELSAT system included about 400 earth stations located in some 150 countries.

Many nations also established domestic satellite systems either to add capacity to their communication channels or to reach sparsely populated areas, such as Indonesia's extensive string of islands. Strategic and tactical military applications caused both national governments and international organizations, such as the North Atlantic Treaty Organization (NATO), to launch military satellites.

Wireless Voice and Data Communications Surge

The capabilities of wireless conveyance of communications via radio waves and satellites spurred development of wireless paging networks for a variety of private sector applications. Initially, private networks transmitted analog messages only. With the development of radio frequency packet-switched networks, called packet radio networks, the capability of private networks progressed to transmission of short data messages. Private networks now can digitally transmit both voice and data.

Historically, trunk radio paging systems, such as Specialized Mobile Radio (SMR), were the predominant private networks. Using these two-way voice services, trunk radio operators send messages over radio devices to radio base stations that direct calls to receivers. Among major customers are companies that communicate with fleets of delivery trucks or freight haulers and public entities that dispatch police cars and emergency vehicles.

Other private radio paging networks provide services that transmit numeric or alphanumeric text rather than voice messages. The paging system sends a brief message through radio towers and satellite networks to an electronic pager or other dispatch-related display terminal. Communication with field engineers has been a major commercial application for text services. In recent years, general consumer use of pagers has expanded as busy family members strive to keep in touch with each other. Technological advances have made it possible to display up to 20 digits on numeric pagers and 80 characters on alphanumeric pagers. In addition, users who have Personal Computer Memory Card International Association (PCMCIA) receivers, known as PC cards, can receive extensive messages from their pagers by downloading them into a notebook or palmtop computer for display.

The evolution of digital technology led to Enhanced Specialized Mobile Radio (ESMR) and packet radio networks. Recently introduced to the market, ESMR can transmit text as well as voice to the same receiving device.

Unlike ESMR and other radio paging systems, packet radio networks send data messages only. News services and other groups that transmit from a central site to numerous remote sites use one-way packet radio messaging systems. Electronic mail (E-mail) and other applications that both send and receive information use two-way systems.

Services offered by packet-radio network providers are expanding and becoming increasingly sophisticated. These include: acknowledgment paging with prestored messages, two-way data messaging via PCMCIA cards, fixed-location data distribution (for use in point-of-sale terminals), remote data collection, information services, E-mail services, industrial remote control, and integration with mobile satellite services to provide seamless network coverage. In addition, modems that are compatible with any provider's services have entered the market.

Cellular Mobile Telephone Systems

The FCC opened the cellular telephone business to competition in the early 1980’s. McCaw Cellular Communications, Inc., one of the initial bidders in the FCC auction, acquired MCI’s cellular business in 1986 and Washington Post Company’s cellular business in Miami in 1987. By 1988, it boasted 132,000 subscribers, making it the largest cellular telephone operator in the United States.

Under the 1984 court-ordered breakup of the Bell System (Judge Harold Greene’s Modified Final Judgment), the FCC gave each of the regional Bell operating companies (RBOCs) one of the two cellular licenses in its region. As the RBOCs, also called Baby Bells, bought licenses outside their territories, a hodgepodge of networks developed across the country. As a result, one cellular phone will not work in every region.

In the United States, most cellular service communication is analog-based at this time. The initial standard was advance mobile phone service (AMPS), which uses 3-kilohertz voice channels. In January 1989, the U.S. cellular industry accepted time division multiple access (TDMA) as the digital standard that would replace AMPS. Then in 1992, the industry accepted as a second standard code division multiple access (CDMA), which would increase the capacity of a cellular system ten fold to twenty fold. Meanwhile, another cellular data transmission technology called Cellular Digital Packet Data (CDPD) is entering the market. CDPD uses the existing cellular network to send data during natural pauses in voice transmissions. By backing different digital standards, U.S. cellular operators are slowing the switch to digital technology.

In comparison, cellular phone companies in Europe set a single standard called Groupe Speciale Mobile (GSM) in the mid-1980’s. As a result, Europe is racing ahead with second-generation digital cellular phone systems. Europe boasts nearly two million digital cellular subscribers, compared to 100,000 in the United States. More than 70 countries in Europe, Asia, and the Middle East, whose combined population totals about one billion people, have adopted GSM.

Personal Communications Services (PCS)

In addition to paging, packet radio, and cellular phone networks, a fourth means of mobile wireless communications, called personal communications services (PCS), has entered the marketplace. PCS, a microcellular digital network that uses low-power, high-frequency radio waves, provides voice and data communications.

Before the FCC began auctioning PCS licenses in the United States in 1994, PCS networks were already operational in France, Germany, and Great Britain. In fact, Germany’s E-Plus Mobilfunk expects to have 3.3 million customers by the year 2000.

The FCC has allocated narrowband and broadband frequencies of the electromagnetic spectrum for PCS use. In the summer of 1994, it auctioned licenses for narrowband channels, applicable primarily for two-way paging services in vertical markets, such as field service and courier dispatch. Six companies bid a total of $617 million for 10 nationwide licenses. Rollouts, expected to begin in late 1995, require about two years.

During the FCC auction of 99 broadband licenses, companies bid $7 billion dollars. For $2.11 billion, Sprint Corporation obtained 29 regional and metropolitan markets, in which it plans to provide telephone and video services to about 180 million customers. AT&T, which bid $1.68 billion for 21 markets, intends to provide coast-to-coast PCS service as early as 1997. A consortium of Bell Atlantic, NYNEX, U S WEST, Inc., and AirTouch Communications, Inc. tendered the third highest bid at $1.11 billion for 11 markets. The consortium also expects to implement a national PCS network in 1997. The final round of auctions covers licenses for small businesses and companies owned by women and minorities. Industry analysts predict that PCS providers will have more than 50 million subscribers in the United States by the turn of the century.

PCS applications include voice, facsimile, and data, including electronic mail (E-mail). New services planned include credit card verification, locator services for vehicle dispatch and tracking, voice paging, acknowledgment paging, and two-way paging with short texts. Messages will be delivered via compact alphanumeric pagers, PCMCIA cards, portable fax machines, personal digital assistants, PCs, or pocket-sized phones that can be used anywhere. Providers eventually may offer video and multimedia services. The ultimate scenario envisions a widespread, microcell-based service involving handheld, battery-powered phones that can be used in any location regardless of which company is the licensed provider.

Enhanced Satellite Communications

The ability to access television programming via large satellite dishes helped fuel popular demand for satellite-delivered entertainment programming, especially among consumers residing in areas where reception of broadcast programming was poor. But this development, whereby households pulled in programs without paying a service fee, infringed on cable companies' revenues. In response, cable companies scrambled their satellite signals. To unscramble them, consumers needed to subscribe to special services.

The need for quality reception in remote or congested areas continued to grow, leading to development of direct broadcast satellite (DBS) services, which beam signals directly to subscribers' home-installed satellite dishes and thus bypass the need for ground stations. Co-owned by General Electric and six cable operators, the first DBS system, PrimeStar Partners, began operation in 1986. In order to receive PrimeStar's satellite-delivered signal, subscribers lease a receiver and a 36-inch-diameter satellite dish, which is placed outside their homes.

In 1990, GM Hughes Electronics created a unit named DIRECTV to create a digital DBS system. Using digital compression technology — which allows for more channels than cable, significantly smaller (18-inch diameter) satellite dishes, laser-disc quality images, and CD-quality audio — DIRECTV rolled out its system in June 1994. The company broke away from the traditional cable model of leasing equipment to subscribers by choosing to sell its system, initially at $700. Users then subscribe to program offerings.

PrimeStar Partners switched from analog to digital service in August 1994. Digital DBS, which ultimately will deliver hundreds of channels, met with extraordinary consumer acceptance.

The Cable Act of 1992 has enabled more companies to participate in DBS and other cable television markets by broadening access to video programming. In essence, the law requires providers to offer their programs at a competitive price to anyone. Encouraged by the combination of programming access and digital technology's success, other companies have announced their plans to launch satellites to provide DBS service.

Whereas DBS provides one-way delivery of audio/video programming, another development, global satellite communications, focuses on creating worldwide networks for two-way voice and data transmission. In late January 1995, the FCC issued licenses to three consortiums, headed by Motorola Satellite Communications, Loral/Qualcomm and TRW, to develop and implement global satellite systems. The networks will transmit voice, data, and facsimile satellite service locally and internationally to subscribers' handheld telephones. The cost of using these systems, with estimated handset prices of $550 to $3,000 and call rates of $.30 to $3.00 per minute, initially will limit the market to those willing to pay the premium for anytime, anywhere coverage. Other potential initial markets are rural areas that lack cellular service and developing countries with limited telephone infrastructures. The global satellite system providers expect to be operational by 1998.

Other Developments in Wireless Technology

Communications based on a cellular architecture, along with development of laptops, PCMCIA cards, personal digital assistants (PDAs) and advanced pagers, have facilitated creation of local area wireless networks (LAWNs) for office buildings and campuses. LAWNs transmit signals across linear distances of 80 feet or more, from one microcell to another. Users need log into their host network only once. As long as they stay within the LAWN system's range, they maintain their connection.

Because these microcellular networks transmit communications over unregulated bands of the electromagnetic spectrum, namely infrared and low power industrial/scientific/medical (ISM) narrowband and spread spectrum, they do not require licenses from the FCC. Spectrum availability, coupled with implementation costs that are lower than wired LANs, motivates companies to install LAWNs and derive an increasingly important benefit: mobile communications within an office site.

u contributed by Nancy Muenker

Wireless Technology: How It Works

Wireless technology makes possible communication that occurs when a device transmits voice or data information to another device via radio frequency channels in the electromagnetic spectrum.

Wireless technologies use radio frequencies of the electromagnetic spectrum to transmit voice or data information. In the United States, the Federal Communications Commission (FCC) allocates and sets the guidelines for proper use of the spectrum. The FCC also determines how bandwidths are licensed and what type of service may transmit in given frequencies.

Specifically, the frequencies for most wireless data communications fall within the ultrahigh frequency band (UHF) of 300 to 3,000 megahertz. They are:

- Cellular: 824–849 and 869–894 MHz
- Private land mobile: 896–901 and 930–931 MHz
- Narrowband personal communication services: 901–902 and 930–931 MHz
- Industrial: 902–928 MHz
- Common carrier paging: 931–932 MHz
- Point-to-multipoint: 932–935 MHz
- Point-to-point: 941–944 MHz
- Personal communication services: 1850–1970, 2130–2150 and 2180–2200 MHz
- Industrial: 2400–2483.5 MHz

The industrial bands use very low power and are unlicensed and generally used for commercial applications, such as cordless phones and local area networks (LANs). Likewise, 40 of the 160 megahertz allocated to personal communication services (PCS) is set aside for unlicensed providers.

Several types of networks transmit wireless communications. They include radio paging, packet radio, circuit-switched cellular, packet-switched cellular, microcellular local area networks and personal communication services.

Radio Paging Networks

Radio paging transmissions may be one-way or two-way systems, point-to-point or point-to-multipoint, and either voice or text.

Trunk radio, such as Specialized Mobile Radio (SMR), is a two-way radio paging network typically used to transmit voice communications. Operating in the 800 to 900-megahertz frequency band, trunk radio operators dispatch and communicate with police cars and emergency vehicles or fleets, such as delivery trucks and freight haulers. Radio devices transmit analog data to radio base stations that direct the calls to receivers.

Other networks transmit numeric or alphanumeric text rather than voice. Senders initiate messages by telephoning the pager number. Under alphanumeric paging, they can also send messages via networked computers that are loaded with special alpha dispatch software.

The paging system sends a brief message, such as a telephone number, through radio towers and satellite networks to an electronic pager or other dispatch-related display terminal. Numeric pagers can display messages of up to 20 digits, and alphanumeric pagers can display up to 80 characters. Pager users who have Personal Computer Memory Card International Association (PCMCIA) receivers, known as PC cards, can download extensive messages from their alpha pagers into a notebook or palmtop computer for display.

Packet Radio Networks
Packet radio communications send data only. They can be one–way messaging systems, which transmit data from a central site, such as a news service, to many remote sites. Or they can be two-way systems, which send and receive electronic mail (E-mail), news feeds, stock market quotes and other information.

Private networks obtain spectrum allocations from the FCC and sell service subscriptions to users. These networks break up incoming signals into blocks of characters, or packets, typically 240 to 500 bytes in size. They identify each packet with addressing information and then transmit them at speeds up to 19,200 bits per second via radio signals. Because messages are sent packet by packet, multiple subscribers are able to share radio frequency channels at the same time.

Although the architectures of packet radio networks vary by provider, they employ similar elements and means of transmission. The basic elements include transceivers, X.400 links, message switches, packet assembler/disassemblers (PADs), radio towers, satellite links, base stations and sites. The transceivers can be dedicated units, or incorporated into laptops or palmtops with attachments that support packet radio services.

The transmission process begins when an originating service creates a message and transmits it via an electronic mail link to a message switch. The switch breaks it up into addressed packets and sends it to an uplink packet assembler/disassembler (PAD). The PAD then transmits the encoded signal to radio towers or a satellite link. The towers or satellites send the message to base stations. The base stations then broadcast the message nationally or regionally.

Each network site examines the message's address to determine whether the recipient unit resides within its coverage area. If it does, the site receives and forwards the message to the appropriate subscriber. If the receiving radio-modem is not located within any of the coverage areas at the time of transmission, the transmitting site holds onto the message for a specified period of time or until the unit reappears. Recipients can retrieve their messages later over a telephone.

Circuit–switched Cellular Networks
Cellular networks typically are analog and use conventional circuit switching technology similar to land-line based telephone networks. Each connection receives a dedicated, two-way telephone line circuit. The basic elements required for cellular communications are a cellular phone, a cell site or transmitting-receiving tower, a mobile telephone switching office (MTSO) and a local public telephone exchange.

Geographic areas are divided into hexagonal cells, which are roughly eight miles in diameter, except in densely populated areas where heavy cellular traffic necessitates smaller ones. Adjacent cells use different frequencies to avoid interference with each others' transmissions. Because frequencies are limited, cells must re-use them. Re-use patterns control how many frequencies each cell may use. The most typical is the 1-in-7 pattern, which stipulates that any cell can use only one-seventh of the available frequencies.

A base station or cell site serves each cell. Subscribers communicate with the site via two radio frequency links: one which transmits and one which receives. When making a call, a cellular phone transmits signals over radio waves to the cell site that serves its cell, or area. If the subscriber is sending a data transmission, the personal computer is attached to a modem, which in turn is attached to the cellular phone.

From the cell site, the call moves to the MTSO via wires or microwaves. The MTSO then routes the call, generally to the local telephone exchange. From that point on, the call becomes a conventional telephone call.

Conversely, when a call is placed to a cellular phone, the MTSO transmits the number dialed to all of its cells. When the MTSO finds the phone, it routes the call to it through the nearest cell.

Maintaining strong transmission for calls to or from in-transit cellular phones requires hand-offs between cells. Computers in the MTSOs monitor the phones' signals. When they weaken, the computers determine which cell will receive the switched call, or hand-off, and on which open frequency. Most cellular systems employ break-before-make switching, which drops the signal for about 100 milliseconds before the next cell picks it up.

The entire cellular band, which is allocated and licensed by the FCC, occupies 50 megahertz in the 800 megahertz band, specifically 824-849 megahertz and 869-894 megahertz. The 50 megahertz of frequency are divided into two categories — the A band for independent cellular carriers and the B band for wireline carriers, those companies that also operate the regular local phone service in a given market. Each band is again divided into two blocks of frequencies: one transmits, one receives.

The most common cellular transmission system in the United States is advance mobile phone service (AMPS), which uses 3-kilohertz analog voice channels. Approximately 58 channel pairs serve each cell. Because each call requires a dedicated pair, the number of calls each cell can handle at one time is limited.

Two forms of digital transmission, time division multiple access (TDMA) and code division multiple access (CDMA), add capacity to the 50 megahertz cellular band by increasing the number of calls each channel can handle at a time. Like AMPS, TDMA uses 30 kilohertz radio frequency (RF) channels. However, the RF channels divide calls into pieces of data (three 8-kilobits per second bit streams) that are identified on the receiving end by the time slots to which they were assigned. This technology enables one cellular channel to handle several calls.

In comparison, CDMA defines channels by code designation rather than by frequency pairs. It fragments all transmissions within a cell and spreads them evenly throughout one wide band (1.25 megahertz) of the cellular spectrum. Because bits of calls mingle with dozens of other conversations, several users can share the same spectrum space at the same time. Each fragment carries a computer-generated code that identifies the phone of origin. The receiving station, which may be a base station, laptop modem or portable phone, uses the code to identify and reconstitute the original signal. All other signals remain indistinguishable as background noise.

Packet–switched Cellular Network

A cellular data transmission technology called Cellular Digital Packet Data (CDPD) uses the existing cellular network to send data during natural pauses in voice transmissions. Basically, CDPD intersperses data amid voice traffic already on the air. Because this technology shares, or piggybacks on, the same bandwidth as cellular voice channels, any cellular provider can offer CDPD–based services without having to obtain licenses for additional frequencies from the FCC.

Like packet radio technology, CDPD breaks data from a computer file or similar source into packets for transmission. As soon as it detects a sufficient idle interval on a cellular voice call, it sends packets onto the channel. When a channel becomes full, CDPD hops to another channel. As CDPD data traffic traverses the network, it jumps from one open cell to another. Voice transmissions, however, always have priority.

The basic CDPD network consists of Mobile End Stations (M–ESs), Mobile Data Base Stations (MDBSs) and Mobile Data Intermediate Systems (MDISs). The MDBS and MDIS are connected to the cellular carrier base station antenna.

Users communicate with a Mobile End Station via a CDPD-compliant modem. The subscriber device segments, encrypts and formats the data into 138-byte frames. The Mobile End Station accesses and communicates with the network over a radio frequency link using CDPD protocol. When the transmitting device finds an open channel among the cellular network’s 30-megahertz channels, it immediately transmits frames at channel speeds of up to 19,200 bits per second. A Mobile Data Base Station retrieves the frames from the network and hands them off to a Mobile Data Intermediate System. At that point, the MDIS routes the packets to either a wireline network or another mobile user.

Microcellular Local Area Networks (LANs)

Microcellular Local Area Networks (LANs), also called Local Area Wireless Networks (LAWNs), reduce the scale of cellular architecture to the area of an office building or campus. The network contains a server, the wired backbone and access points that command an operating range, or microcell, for wireless devices. A LAWN’s configuration may be peer–to–peer based, whereby each node must be able to communicate directly with all other nodes, or hub–based, where one wireless node acts as a central controller.

Users need to log onto the network only once. When they move from one microcell to another, their connection is handed off from the antenna of one access point to the next one. As long as they stay within the LAWN’s range, they maintain their connection.

Wireless LAN communications may be transmitted via spread-spectrum, narrowband or infrared bands. Spread-spectrum transmission uses a range of frequencies in the unlicensed industrial electromagnetic band between 2400 and 2483.5 megahertz. Not only can signals cover a linear distance of at least 80 feet, but they also can pass through most walls.

Narrowband transmission also uses an industrial portion of the electromagnetic spectrum, but in the 902 to 928 megahertz range. It, too, can cover an 80-foot or more linear distance and pass through most walls.

In comparison, infrared transmission uses that part of the spectrum just below visible light. Unlike spread-spectrum and narrowband transmissions, it cannot pass through walls or opaque objects. It does have the benefit, however, of immunity to most forms of electromagnetic interference.

Personal Communication Service (PCS)

Personal communication service (PCS) technology operates in the electromagnetic spectrum's narrowband (900 megahertz) and its broadband (1800, 1900, 2100 megahertz) frequencies. Forty megahertz in the 160 megahertz broad bandwidth is available to unlicensed users, such as local area networks. Whereas narrowband PCS is best suited for paging services in vertical markets, such as courier dispatch or field service, broadband PCS lends itself to inter-office, campus and other localized transmission applications.

Designed to send data, fax and voice, PCS technology is all digital. It capitalizes on conventional cellular architecture by using microcells. PCS, however, uses less powerful transmitters, a wider bandwidth and cells that often measure in hundreds of feet instead of in miles.

Its transmission process is similar to the conventional cellular process. Smart digital devices transmit data via radio frequencies to antennas, which are spaced every few hundred feet. An antenna hands off signals to the next antenna and finally to alphanumeric pagers, laptop PCs or similar receivers.

u contributed by Nancy Muenker

Wireless Technology Industry

The number of players participating in the wireless technology industry grows with each technological advancement. In the 1990's, three key communications developments are commanding the industry's financial, marketing and technological attention. They are digital direct broadcast satellite (DBS) services, personal communications services (PCS), and low-earth orbit and medium-earth orbit (LEO and MEO) global satellite systems. Meanwhile, paging, cellular telephone and other standard wireless communications services continually add advanced features and applications to address our increasingly mobile society.

Communication services providers and product manufacturers make up today's wireless technologies industry. Both groups often create consortiums or alliances in order to pool resources to plan and implement major projects. For example, DIRECTV, a unit of GM Hughes Electronics, turned to an experienced consumer electronics manufacturer, RCA-Thomson, to help it develop a digital DBS system with a marketable price and to distribute it to retail consumers. On a grander scale, Bell Canada Ltd., Lockheed Corporation and Sprint Corporation are among those companies participating in Motorola's implementation of its multi-billion dollar global satellite system, Iridium.

Primary categories within the wireless technologies industry are: paging systems and trunk radio, packet-switched radio, cellular telephone, local area wireless networks, wireless cable, satellite-based wireless systems, and PCS.

Paging Systems
Conventional paging systems offer regional and nationwide one-way messaging to subscriber devices. The messages may be numeric only, such as a telephone number, or alphanumeric, which contains both letters and numbers. SkyTel, whose service covers 90 percent of the continental United States, is the predominant player in this field. Other providers include Pagenet and Pagemart.

Trunk radio, a two-way radio paging network, typically has been used to transmit voice communications. For example, Specialized Mobile Radio (SMR) operators dispatch and communicate with freight haulers or similar fleets. Racotek Inc., Nextel Communications Inc., and other vendors also offer trunk radio data services for paging and file transfer applications.

A recent paging system development is enhanced paging services (EPS), which transfer data, such as corporate bulletins or on-line news updates, one-way. EPS's message length capability of 30,000 characters far surpasses conventional paging's capability of 240 characters. EPS can also simultaneously broadcast messages to a number of receivers. Current suppliers are Mobile Telecommunications and Motorola Advanced Messaging Group, whose EPS service is called EMBARC (Electronic Mail Broadcast to a Roaming Computer).

Radio Frequency (RF) Packet Radio
RF packet radio, also called private packet radio, transmits short data messages either

one-way or two-way. Typical applications include messaging; point-of-sale transactions, such as credit card debiting; telemetry, which monitors remote devices, such as vending machine supply levels and utility meter readings; and database query, such as obtaining a current stock market quote.

Two providers define the private packet radio industry: Ardis Company and Ram Mobile Data, Inc. Ardis provides coverage in 10,700 metropolitan regions in the United States, Puerto Rico and the Virgin Islands. The company reportedly controls over 90 percent of its market. In Los Angeles, New York, San Francisco and Washington, D.C., its data rates reach 19.2 kilobits per second using Radio Data Link Access Protocol. In these three locations, its data rates are faster than those of cellular telephone modems, which typically run a maximum of 14.4 kilobits per second. Elsewhere, however, its data rate is considerably slower, 4.8 kilobits per second, using Motorola Data Communications MDS-4800 protocol.

Hardware suppliers for Ardis services include AT&T, Digital Equipment Corporation, Hewlett-Packard Company, IBM, NCR and Toshiba America Inc. Subscribers can obtain middleware (products that allow applications running on incompatible operating systems to communicate with each other) and applications from Airsoft, Business Partners Solutions, Nettech and others.

In comparison, Ram Mobile Data, Inc. provides services in 6,300 regions in the United States. It uses Mobitex protocol to transfer data at 8 kilobits per second. Ericsson GE and Intel supply hardware for its network. Applications suppliers include AT&T, Lotus and others.

Cellular Telephones
Most cellular telephone networks use analog-based circuit switching technology. The most common transmission system in the United States has been advance mobile phone service (AMPS), which uses 3-kHz analog voice channels modulated onto 30-kHz FM carriers. Two digital technologies evolved to address the need to increase each channel's call capacity: time division multiple access (TDMA) and code division multiple access (CDMA). In 1989, the Telecommunications Industries Association (TIA) adopted TDMA as a digital standard, and in 1993, it accepted CDMA. Any cellular provider is capable of offering circuit-switched transmission.

Neither TDMA nor CDMA, however, offers a low cost mechanism for data transmission. A consortium, comprised of McCaw Cellular Communications, Inc., GTE Corporation, Ameritech, Bell Atlantic Corporation, NYNEX Corporation, Pacific Telesis Group and Southwestern Bell (now SBC Communications), developed specifications for a packet-switched cellular technology. Called Cellular Digital Packet Data (CDPD), it intersperses data amid voice traffic already on the air. Any cellular provider can offer CDPD-based services without having to obtain licenses for additional frequencies from the Federal Communications Commission (FCC), because this technology shares the same bandwidth as cellular voice channels.

Rollouts of CDPD services began during 1994. GTE Mobilnet provides coverage in 74 metropolitan regions, and McCaw Cellular Communications, Inc. offers coverage nationwide. Coverage by the five participating regional Bell operating companies (RBOCs) is within each of their specific regions.

To implement their networks, CDPD providers require hardware and software that, in most cases, is supplied by outside vendors. Key suppliers of the CDPD subscriber device, which essentially is a modem and radio bundled together, are Cincinnati Microwave, Motorola, PCSI and Sierra Wireless. A number of software companies are competing to supply CDPD providers. They include Advanced Control Technologies, Advantis, EDS, General Programming, Lotus, Microsoft, Navtech, Software Corporation of America, Sun and Verifone.

Whereas in CDPD products the modem and radio are integrated, in circuit-switched cellular products they are not. The market offers a variety of cellular modem products to meet non-CDPD cellular users' digital transmission needs. Some are Personal Computer Memory Card Industry Association (PCMCIA) modems, including Type 2 and Type 3. Others combine a cellular phone and external modem. And others are pocket fax/data modems or internal modems for laptops. While most connect directly to phones, others require purchase of an external interface box or a given vendor's cable or adapter. Likewise, most are compatible with the market's most popular cellular phones, but some are compatible only with select phones.

For the most part, cellular modems are compatible with any Macintosh or Windows platform with an EIA-232 serial port. Some, however, work only with specific platforms, such as Compaq or Toshiba. All run at speeds of 14.4 kilobits per second. Their wireless protocols are MNP10, Enhanced Throughput Cellular (ETC), Motorola Enhanced Cellular Control (ECC) or U.S. Robotics High Speed Technology (HST).

Thirteen suppliers dominate the cellular modem market. They are Air Communications Inc., AT&T Paradyne, Apex Data Inc., Compaq Computer Corporation, Data Race, Megahertz Corporation, Microcom Inc., Motorola UDS, Powertek Industries Inc., Racal-Datacom Inc., Toshiba America Inc., U.S. Robotics and Western Datacom.

Local Area Wireless Networks (LAWNs)
For private data transmissions within a limited geographic area, such as a building or office park, companies can install local area wireless networks (LAWNs) that use unlicensed narrowband, spread-spectrum or infrared electromagnetic frequencies. These networks are based on microcellular architecture. Each contains a server, the wired backbone and antennas for access points that command an operating range, or microcell, for wireless devices.

Customers can choose a supplier that owns and operates the LAWN and bills them for services, such as Metricom Inc. and Pinpoint Communications Inc., or they can purchase spread-spectrum base stations, antennas and other equipment from manufacturers and set up their own networks. Suppliers of the latter option include Gambatte Inc., Proxim Inc. and Spreadnet.

Wireless Cable
Wireless cable, which has existed since the 1970's, transmits video programming via microwave towers to some 700,000 U.S. subscribers. Financial, technological, regulatory and other difficulties have plagued the industry. The Cable Act of 1992 , though, minimized a major limitation, access to programming, by requiring producers to sell their programs to any buyer at competitive prices. Today, some 175 systems operate in the

United States.

Digital technology promises to put wireless cable in an even stronger position to compete for cable customers. American Telecasting Inc. and five vendors, namely Andrew Corporation, California Amplifier, Emcee Broadcast Products, Microwave Filter Company, and set-top manufacturer Zenith Electronics, have created Wireless Cable Digital Alliance to test digital compression over four of its systems.

Exploring a different competitive approach, Videotron is introducing its Videoway interactive technology in systems that it recently acquired in San Diego and San Francisco, California; Spokane, Washington; and Tampa, Florida.

Other operators are adopting a wait-and-see attitude toward technological advancements. In order to build their customer bases, they are focusing on maintaining lower prices than cable operators and providing top customer service.

In addition to American Telecasting Inc. and Videotron, wireless industry cable players include CAI Wireless, Cable-Maxx, Coastal Wireless Cable Television, Daniels & Associates and General Instrument Corporation.

Personal Communications Services (PCS)
The FCC began auctioning licenses for personal communication services (PCS) frequencies in 1994. License holders expect to implement their networks in 1997.

Six companies won narrowband PCS licenses in 10 markets. AirTouch Communications, Inc., currently a cellular voice and data provider, will offer PCS service for acknowledgment paging and short messages. BellSouth Wireless Inc. plans to provide acknowledgment paging, electronic mail (E-mail), credit card verification, telemetry and locator services. Destineer Corporation will implement two-way paging, acknowledgment paging and E-mail services. Another cellular voice and data provider, McCaw Cellular Communications, Inc., will provide two-way messaging. Pagenet will offer voice paging, and Pagemart will offer two-way paging and acknowledgment paging.

The FCC granted broadband PCS licenses for 99 markets during the January 1995 frequency auction. Viewing PCS as the next major development in public communications networks, long-distance service carriers, local telephone companies, cellular telephone service providers and cable operators submitted bids. The top three bidders (namely Sprint Corporation, AT&T, and a consortium of Bell Atlantic, NYNEX, U S WEST, Inc., and AirTouch Communications, Inc.) obtained 61 of the regional and metropolitan markets. Besides data transmission, the companies intend to provide telephone and video services.

Satellite-based Systems
In the mid-1990's, two satellite-based systems have captured the wireless industry's attention: direct broadcast satellite (DBS) and global satellite.

DBS, an alternative to cable television, transmits programming via geostationary satellites, positioned 22,300 miles above Earth, directly to subscribers' homes. Two systems, PrimeStar Partners and Digital Satellite System (DSS), currently offer DBS in the United States.

General Electric and six cable operators, including TCI and Time Warner, own PrimeStar Partners, which began operations in 1986. The company leases its minimum 36-inch diameter satellite dish, receiver and other components to subscribers. General Instrument Corporation produces PrimeStar's equipment. In order to increase the number of channels it can offer and to improve image and audio quality, PrimeStar converted to digital compression technology in mid-1994.

In comparison, DSS has used digital compression technology from the moment it began broadcasting in June 1994. DIRECTV, a unit of GM Hughes Electronics, and UBBS, a subsidiary of Hubbard Broadcasting, are the two companies that provide DSS programming. RCA-Thomson produces the 18-inch diameter satellite dish and other components and sells them to subscribers through its retail outlets. Systems start at $700. After one million units have been sold, Sony will also become an equipment supplier.

A third DBS player, EchoStar Communications Corporation, will enter the market after it launches its own satellite, scheduled for late 1995. The company eventually expects to provide 250 channels.

Market analysts have likened consumer acceptance of the DSS product, which resulted in sales of nearly one million systems during its first year, to that of VCRs and televisions when they first hit the market. Based on this record, they expect DBS to have between 10 million and 15 million customers by the year 2003.

The other satellite-based technology that has captured industry focus, global satellite systems (also known as LEO and MEO satellite systems), will provide two-way voice, data and facsimile communication internationally via handheld telephones. In early 1995, the FCC granted licenses for development and implementation of three initial systems: Motorola’s Iridium, TRW’s Odyssey and Loral/Qualcomm’s Goldstar. These licensees plan to become operational in 1998.

Implementation of these systems requires coordination and cooperation among scores of telephone companies around the world, national and international government entities, technology firms, from telephone unit manufacturers to rocket launchers, and key investors. For example, Iridium’s major shareholders include Motorola, Nippon Iridium Corporation, DDI Corporation, Bell Canada Ltd., Sprint Corporation, Lockheed Corporation, VEBA AG and numerous Japanese, South Korean and Taiwanese firms.

Groups that lost out during the FCC’s initial licensing process also hope to implement global satellite systems. Among them are Constellation Communications and Mobile Communications Holdings, whose applications the FCC deferred until January 1996 to give them the opportunity to improve their financial qualifications.

u contributed by Nancy Muenker

Wozniak, Stephen (1950 –)

American computer designer, primarily known for designing and building the original Apple computer and co-founding industry giant Apple Computer, Inc. with partners Steven Jobs and Armas "Mike" Markkula. Currently, Wozniak is Editorial Director for an industry publication called *Envisioneering*.

California-born Wozniak was fascinated by electronics as a youngster. The Silicon Valley was a booming electronics center and he and his friends caught the fever. They did odd jobs for neighbors who worked in the Valley in exchange for electronic parts.

Wozniak focused on courses in electronics at Homestead High School, where he became a star pupil. He studied computer mainframes and software during teacher-arranged study sessions in nearby GTE Sylvania's computer room, and devoured trade magazines. During this time he became friends with a junior high student named Steven Jobs who was also an electronics buff. Their friendship and mutual interests would later lead the "two Steves" to make a fortune.

Although he attended the University of California at Berkeley and the University of Colorado in Boulder, among others, electronics whiz Wozniak didn't do well in college or obtain a degree. While attending Berkeley, however, Wozniak was intrigued by an underground movement called "phone phreaking." This led him to begin manufacturing "blue boxes" that made free long-distance calls by simulating the necessary telephone tones. His partner in this illegal venture was Steven Jobs, who was attending Homestead High School several years behind Wozniak. Jobs obtained the parts and Wozniak built the boxes. They sold several hundred, mostly to college students, for $150 each.

After dropping out of college, Wozniak worked as a computer programmer for a small company, Tenet, which folded in 1972. The next year he joined Hewlett-Packard Company (H-P) as a technician and was promoted within 6 months to engineer in the pocket calculator manufacturing division. Despite the promotion, he was not highly regarded at H-P where his lack of a college degree was often held against him.

During this time, Wozniak married Alice Robertson, whom he met through his home-based dial-a-joke telephone service. He also discovered the Home-brew Computer Club in Palo Alto, California comprised of about 1,500 young computer enthusiasts. It became very important to him and he never missed the biweekly meetings. Here he became re-acquainted with Steven Jobs. About this time, in fact, Wozniak and Jobs collaborated on the design of a popular video arcade game for Atari called *Breakout*.

In his spare time, Wozniak was working on an innovative computer circuit board of his own design. Jobs saw the potential in it and convinced his friend to try to sell it to computer hobbyists. So the two Steves joined forces and began building the circuit board in earnest in the garage of Jobs's supportive parents. Although both were computer buffs, Wozniak was the technical expert and Jobs the marketing visionary. They financed the project by selling Wozniak's calculator and Jobs's Volkswagen van. They called their new machine the Apple Computer, and in 1976 sold 600 units at $666.66 each. Despite its humble beginnings in a garage, the Apple became the genesis of a huge new industry in personal computing.

Wozniak, Jobs and retired electronics engineer “Mike” Markkula (their new partner) incorporated the company in January 1977, calling it Apple Computer, Inc. Working full time in his engineering capacity, Wozniak’s title was Vice President in charge of research and development. That same year, the company successfully launched the Apple II PC, the first to be sold in preassembled form and the first commercially successful computer for personal use (earning $2.7 million the first year and $200 million by 1980). Totally immersed in designing the Apple II, Wozniak was divorced during this time.

A true American success story, Apple Computer, Inc. dominated the burgeoning personal computing market. When it went public in 1980, Wozniak’s stock was valued at $135.6 million and his ex-wife’s was valued at $42 million.

Fascinated by flying since his days at H-P, Wozniak was involved in a private plane crash in 1981 and took a leave of absence from Apple. During his leave, he founded a corporation called Unison and funded a festival that combined a rock concert and computer fair in the mountains east of Los Angeles. The festival cost Wozniak more than $10 million over the two years he was involved. Meanwhile, Apple Computer, Inc. reached annual sales of $1 billion in 1982.

Wozniak returned to Apple in 1983. But the mid-1980’s were turbulent for Apple as external market pressures and internal squabbling took their toll. In 1984, Wozniak quietly left Apple again because he was disenchanted with the company’s emphasis on its new Macintosh computer with which he was not involved. He sold all his stock and formed a company called Cloud 9 or CL-9, Inc., which manufactured wireless remote control devices for home appliances and televisions. It went out of business in 1989.

After Steve Jobs’s forced departure from Apple in 1985, Apple’s CEO John Sculley persuaded Wozniak to return to help out in the Apple II division. But Wozniak did not stay long. After leaving Apple Computer once again, he finally obtained his elusive bachelor’s degree in computer science and electrical engineering from the University of California at Berkeley.

Currently, Wozniak is Editorial Director for *Envisioneering*, a publication offering insight, news and perspectives on PCs, audio, video, graphics and multimedia.

Although still involved in the industry, Stephen Wozniak will probably always be remembered as one of the “two Steves” who founded a personal computing company called Apple in a garage and helped quickly take it to a leadership position, changing the face of computers forever and making a fortune in the process.

u contributed by Kay S. Volkema

Zworykin, Vladimir Kosmo (1889 – 1982)

Russian-born U.S. inventor, physicist and electronics engineer considered the father of modern television (along with arch rival Philo T. Farnsworth). Best known for inventing the iconoscope (electronic camera) and kinescope (picture tube).

Vladimir Zworykin was born in Russia. During World War I, he was a radio specialist in the Russian Army Signal Corps working with x rays and gaseous and electrical discharges, and was a member of the Russian Society of Wireless Telephone and Telegraph. In 1919, after the war ended, Zworykin emigrated to the United States. A year after arriving in America, Zworykin accepted a position with Westinghouse Electric Corporation. In 1924, he became a naturalized U.S. citizen, and earned his doctorate in 1926 at the University of Pittsburgh.

Early in his career with Westinghouse, Zworykin resumed research he began in 1907 on the cathode-tube principle. That research resulted in his invention of the first practical television camera, the iconoscope. The camera, for which Zworykin applied for a patent in 1923, used photoelectric effects to scan images and convert them into electrical current. In 1924, Zworykin applied for a patent for his kinescope, the first television receiver, or picture tube. Prior television systems had been electromechanical, often depending on rotating perforated discs. The iconoscope and kinescope together formed the first fully electronic television system.

Westinghouse's management was unimpressed by early presentations of Zworykin's inventions; however, officials at Radio Corporation of America (RCA) saw the potential in his developments. In 1929, Zworykin became RCA's Director of Electronic Research, and the company relied on Zworykin's technology to develop its electronic television system. Unfortunately, controversy would soon erupt over the originality of Zworykin's work.

During the same period, American inventor Philo T. Farnsworth was working on technology similar to Zworykin's. In the early 1930's, Farnsworth filed a complaint with the patent office. Farnsworth claimed Zworykin had used his ideas to develop the RCA systems. After investigating the complaint, the patent office ruled in Farnsworth's favor. Farnsworth later licensed the rights to his inventions to RCA.

In 1954, Vladimir Zworykin retired from RCA as a Vice President, but continued as a consultant. After leaving RCA, he joined the Rockefeller Institute for Medical Research in New York City as Director of the Medical Electronics Center. He remained there until 1962.

Zworykin was granted over 120 patents during his career. In addition to the iconoscope and kinescope, his inventions included the electron microscope, electronic controls, and infrared detection and imaging devices. Among the books he authored are *Television* (1940), *Electronic Optics and the Electron Microscope*, (1945), and *Television in Science and Industry* (1958).

Vladimir K. Zworykin's contributions to television, science and engineering were recognized in 1967 when he was honored with the National Medal of Science from the National Academy of Sciences. Zworykin died in 1982.

u contributed by Susan P. Sanders

Timmer, J.D. Jan (1933 –)

(Pictured, Norman Schwarzkopf and Jan Timmer)

Business executive currently President of multinational Philips Electronics located in The Netherlands. Philips' business interests include consumer electronics, telecommunications equipment, semi-conductors, educational media and entertainment ventures.

J.D. Jan Timmer was born in Lienden, The Netherlands, on February 20, 1933. In 1952, when Timmer was 19, he joined Philips Electronics. Philips is a multinational company with 265,500 employees worldwide. Its business ventures include consumer electronics, telecommunications equipment, semi-conductors, lighting components, industrial electronics, medical equipment, educational media and entertainment ventures. In his years with Philips, Timmer has held a number of progressively more responsible positions. In 1963, he was named Manager of Philips' operations in Ethiopia. In 1968, Timmer returned to The Netherlands and was appointed head of Philips' Tropical Africa Regional Bureau. In 1970, he was assigned to the Corporate Staff Bureau, where he became Director in 1973.

Timmer took charge of all Philips' South African activities in 1977. In 1981, he became a member of the Group Management of PolyGram, and he was appointed President and Chief Executive Officer of PolyGram International Ltd. two years later. PolyGram is a music and entertainment company of which Philips owns 75 percent. While Timmer was head of PolyGram, the company's profitability grew significantly, in part due to its acquisitions strategy. A recent Philips' success was the popularity of the 1994 motion picture *Four Weddings and a Funeral*, which was largely financed by PolyGram.

In September 1987, Timmer became a member of Philips' 14-member Group Management Committee when he was named Chairman of the Consumer Electronics Division. Timmer was appointed President of Philips and Chairman of the Board of Management and the Group Management Committee on July 1, 1990.

When Timmer became Philips' President in 1990, the company was facing staggering issues, including losses exceeding $2 billion and increasing isolation in the Philips-dominated town of Eindhoven, The Netherlands. After assuming leadership, Timmer implemented a dramatic restructuring strategy that he called Operation Centurion to commemorate the company's hundredth anniversary in 1991. To launch Centurion, Timmer hosted a series of management meetings in Philips business locations, including The Netherlands, Hong Kong, Brazil, Belgium and the United States.

As a result of Centurion, the company has changed significantly. Business units have been reorganized, production operations have been transferred to Asia (where labor costs are lower), several factories have been closed and 68,000 jobs have been eliminated. By 1994, the company had backed off from the brink of bankruptcy and was reporting profits. However, key business issues — such as what product niche the electronics giant should target — remain. Under Timmer's guidance, the firm has hired fresh management talent and is creating a business culture characterized by careful planning and shared responsibility for the company's future.

u contributed by Susan P. Sanders

Structured Programming

A programming design that uses standard elements, such as modules and flowcharts, to create computer programs. It is the design used in almost all programs today.

Structured programming provides a standard framework for the design of computer programs. It uses commonly accepted structures to streamline software development, eliminating the need for creating new formats each time a computer program is designed.

Early computer programs were written using unstructured programming methods. These programs simply contained one instruction after another, continuing until the desired result was reached. Then the program would move, or "branch," to a new area, and follow a new set of instructions.

This format made early programs difficult to understand and sometimes impossible to modify. Programmers trying to make changes in these programs often hit roadblocks caused by the complex branching structures they contained. Patching changes into different areas of the program was one solution; however, it was difficult to tell how changes made in one area might affect the operations of another. Unstructured programs were often described as containing "spaghetti code" due to their tangled lines of computer language and complex branching formats.

As computers became more powerful, the programs needed to operate them became more complicated, and the time available to write them more precious. Programmers realized they needed new methods to make programming easier and less labor intensive. In 1968, computer scientist Edsger W. Dijkstra demonstrated a more systematic programming method. His method demonstrated that branched programs were not necessary, and that software written without branching was easier to follow. His theories, which became known as structured programming, were incorporated into the structured programming languages, such as Pascal, Ada and C, that were introduced in the 1970's and 1980's and are still in use today.

Structured program design begins by identifying the tasks the program will accomplish. Once these tasks are determined, they are assigned to individual modules. These modules are usually organized by importance, with the program's main functions considered first, followed by additional modules until the program's lowest level is reached. Programmers often use a hierarchy, or structure, chart to illustrate the modules of a program and how they relate to one another as the program is being designed.

After the modules are identified, the logical flow of the program is designed for each module, based on three basic operations or control structures: sequence controls, selection controls, and repetition controls. Sequence controls arrange processes such as opening and closing files in a logical order. Selection controls decide how sequences are chosen by specifying certain conditions that must be met. Finally, repetition controls specify instructions that repeat as long as certain processing conditions stay constant. The instructions repeat until the condition is no longer true or until the condition is met.

Structured programs are easier to understand and more flexible than their predecessors. Their modular design makes it easy to transfer parts of one program to another, eliminating the need for rewriting program code when similar functions are required. The smaller units in modular programs also can be developed, tested, and maintained individually, making such programs easier to change and modify.

u contributed by Sonia Weiss

Spielberg, Steven (1947 –)

American motion picture producer, director and studio co-owner. Spielberg is regarded throughout the world as the most commercially successful film director. His company, Amblin Entertainment, was recently folded into a new company called DreamWorks SKG. DreamWorks is a production studio co-founded by Spielberg, Jeffrey Katzenberg and David Geffen. Additionally, the new company has launched DreamWorks Interactive, a division that plans to build interactive elements around DreamWorks productions. DreamWorks SKG is located in Universal City, California, which is actually the Universal Pictures lot in Burbank.

It's been said that many of Spielberg's movies, especially the early ones, bordered on the biographical. But if a movie of his life were actually put on the screen, critics would say it was too ordained, too transparent and just plain over-written. Indeed, most of Spielberg's actions as a youngster are legendary and certainly have an "only in Hollywood" feel, except these stories happened in such ordinary places as Ohio, New Jersey, Arizona and northern California.

Steven was the first child of Arnold and Leah Spielberg. Arnold was an electrical engineer who worked in the then-new field of computers. His legacy to his oldest child was an interest in astronomy, technology and science. Engineers, by default, are usually thorough, pragmatic, organized and logical, and so it was with Arnold. Leah was the opposite of Arnold. She was an artist who had trained as a classical pianist. She was ever optimistic and seemed to have a gentle, whimsical outlook on life. Her gift to her son seems to have been the warm world of make-believe.

The Spielbergs strictly censored their children's television and film exposure. When Steven was four or five years old, he would become scared when he saw certain TV shows. Other things scared the little boy, too: trees outside his window at night, creatures in the closet and a big dog that snarled at him. This probably prompted Arnold to tell Steven that the animals and actors weren't real when the two went to Steven's first movie, *The Greatest Show On Earth.* But the film and its circus action had an immediate impact on the boy. He loved the feeling of being "there" with the animals. Cecil B. DeMille's movie was so powerful, Spielberg felt like he was a part of it. It was an intoxicating first movie experience.

As Spielberg grew older he learned that he could gain power over his fears by telling scary stories to his three little sisters. He simply transferred his deepest, scariest thoughts to the stories he made up for them. Sometimes he would take his stories further and set up scenes to spook them. Actually, he says, he tormented them.

His parents, thinking parakeets would be safe and non-frightening pets, bought several for Steven, who trained them to live outside their cages on the curtain rod in his room. The most telling aspect of parakeet ownership for the youngster was the names he chose. He says he would pick a name he liked and then name the subsequent birds like sequels: name II, name III, etc.

The Spielberg family also moved frequently, making it difficult for Steven to find stability and establish a base of friends. A change occurred, however, when Spielberg was 12 years old. His mother bought a movie camera for his father, and in short order, Steven became the family camera man. He started by "directing" their vacations and outings. Then he moved on to his own productions starring his sisters and neighbor kids. Soon he was filming movies and then showing them in his parents' living room. He charged each movie-goer 25 cents plus extra for popcorn and drinks. To finance his "studio," Spielberg started a citrus-tree whitewashing/debugging business. He charged 75 cents per tree. Six trees equaled one roll of film. His three-and-a-half minute western, *The Last Gun,* had a budget of $8.50, or just over 11 trees. At age 13, Spielberg became an award-winning movie producer and director when he created a 40-minute movie titled *Escape to Nowhere.*

The escapades of Spielberg's junior and senior high school years were prophetic. As a youngster, he set up and watched toy trains wreck over and over again, frequently damaging the trains. But with film, he could preserve a great wreck and his toys. He set up the train-wreck of all train-wrecks and filmed it complete with plastic actors' "reactions." As he moved on to other productions, he filled his parents' house with cables and lights. When a specific location was called for, he maneuvered his way into situations a normal teenager probably wouldn't even consider. For example, Spielberg successfully arranged to use both a hospital wing and an airport runway for location shots.

Most importantly, movies gave Spielberg the chance to work out the fears he carried with him. He could film and thus preserve happy family times. He could also edit out unhappy times. He could then take control one step further by creating a whole new world with his camera.

Spielberg said that his father tolerated his movie business while his mother abetted him. She routinely "believed" him when he said he was sick and allowed him to stay home from school one day a week. It was the only way the young filmmaker could keep up with his various editing schedules. When he was 16, Spielberg made his first epic, titled *Firelight.* It took just 24 hours — straight — to write the screenplay and an entire year of weekends to produce it. Spielberg hired Arizona State drama students to act in the film. It was shot without sound, but when the film was done, he brought the actors back in to lip sync their own parts. The finished film was two-and-a-half hours long and cost $500 to make. When *Firelight* was finished, the local theater owner was persuaded to shut down for a night so it could be shown to an audience. Spielberg grandly rented limousines and klieg lights for the world premier of *Firelight.* The movie recouped its original $500 plus an additional $50 profit. Very soon, however, the family moved again, and the process of finding new friends and trying to fit in started all over again. Shortly after moving from Arizona to northern California, Spielberg's parents separated. They eventually divorced.

During the summer of 1965, when Spielberg was 17, he took a tour of the Universal Pictures studios. The tour didn't stop at any sound stages, and since that's what he came to see, he went off by himself. Finding a stage in use, he settled in to watch others live his dream. A friendly Chuck Silvers, head of the editorial department, discovered Spielberg lurking in the shadows and chatted with him. Silvers went so far as to give the teenager a pass to get back on the lot the next day. Not only did Spielberg go back the following day, but he never really stopped going back. Every day that summer, Spielberg put on a suit and sneaked back on the lot. He actually took over an empty office space and put his name on the door.

When Spielberg enrolled in California State University at Long Beach, he arranged his schedule so he could continue to spend time on the Universal lot. And he continued to make amateur movies. The English major's third movie made while in college was titled *Amblin'.* Shot in 10 days for $10,000, the movie depicted a young couple hitchhiking from the desert to the Pacific coast. The movie also earned him a seven-year television production contract with Universal Pictures. Spielberg wasn't quite 21 years old.

Spielberg's television direction credits include episodes of *Night Gallery, Marcus Welby, MD* and *Columbo.* His most successful TV production was a movie of the week titled *Duel.* A suspenseful thriller unlike anything on television at the time, it won numerous awards and was released in theaters in Europe and Japan bringing in over $5 million in the overseas markets. Soon Spielberg got his big break in feature films with big name stars, a full crew and studio backing. The list of Spielberg movies that he directed in the 1970's includes two blockbusters: *Jaws* and *Close Encounters of the Third Kind.* Hugely successful films that Spielberg directed or produced in the 1980's include *ET: The Extra-Terrestrial, Raiders of the Lost Ark* and *Poltergeist.*

In 1984 Spielberg started Amblin Entertainment. The new company was described as a studio within a studio, since it was located on the Universal grounds. However, with success came criticism. For years, Spielberg was, in some ways, discounted because his movies were mostly light-hearted or fantastical. Many critics wrongly dismissed these types of movies as easy to make. Yet when Spielberg did make adult, special-effects-free movies, such as *The Color Purple* or *Empire of the Sun*, he was criticized for that, too. He responded by ignoring these critics and enjoying the commercial success of his movies, and he kept on working.

The result was that 1993 was a year of triumph for Steven Spielberg. *Jurassic Park* and *Schindler's List* were both released to an eager public. *Jurassic Park* has since become the highest grossing movie of all time; it is laden with special effects and a Spielberg-type of wonder. When *Schindler's List* was released, its depiction of Oskar Schindler, who saved and sheltered thousands of Jews during World War II, touched the world. It's estimated that over 75 million people have seen the movie, which finally secured for Spielberg the stature and respect in the film community that had been so elusive. With the addition of these two film accomplishments, Spielberg had directed and/or produced an amazing seven of the 20 top grossing films of all time.

By 1994 Spielberg's company had become very profitable, and he seemed ready for the next challenge. Entering into a collaboration with two other highly creative men, David Geffen of David Geffen Company (record label and film company under parent MCA Inc.) and Jeffrey Katzenberg (who had just left Walt Disney Studios), Spielberg announced the formation of DreamWorks SKG. The industry immediately started buzzing about the possibilities of a collaboration among these three giants.

Katzenberg was part of the team that had brought success to Disney studios in the 1980's and early 1990's. But by the fall of 1994, just after two highly successful animated releases, *Beauty and the Beast* and *The Lion King,* it was announced that Katzenberg was leaving the company. Rumors quickly circulated that he and David Geffen were teaming up. The two had been friends for a long time, and Geffen's company contract with MCA was scheduled to end in April 1995. Spielberg's name then became part of the rumor mix, and the possibilities seemed incredible.

With much fanfare, DreamWorks SKG was launched on October 12, 1994. The three partners invested $33.3 million each, agreed to fold Geffen's company and Amblin Entertainment into the new company, divided up responsibilities, and started brainstorming with some very talented brains.

DreamWorks announced it would produce television shows, live-action and animated motion pictures, and records. But the plan from the start, and the element that brought so much excitement to the partnership, had always been the exploration of the next level of movie and video entertainment — interactivity. So while DreamWorks was working out agreements with Capital Cities/ABC for a television venture and with Home Box Office (HBO) for cable TV rights, computer connections were also being sought.

The spring of 1995 was an active time for DreamWorks as far as the press was concerned. With the speculation, agreements and details of the ABC and HBO ventures came even more speculation about DreamWorks pairing up with countless other banks, investors and partner companies, as well as computer companies.

Towards the end of March, it was confirmed that Paul Allen, co-founder of Microsoft Corporation, personally invested $500 million in DreamWorks SKG. (Allen remains on the board of Microsoft but left the company in 1983.) Three days later Microsoft and DreamWorks made news again. It was announced that Microsoft, led by Bill Gates, would invest $15 million to form a new joint venture called DreamWorks Interactive. Microsoft, the software giant, is the leading producer of CD-ROM titles and a powerful partner for DreamWorks.

The overall plan is for DreamWorks to get busy producing and using the amazing talents of Spielberg, Geffen and Katzenberg. Their temporary headquarters will continue to be located at the former Amblin Entertainment facilities. Speculators have said that DreamWorks will release from one to three movies in 1996. The company's first animated movie will be released in late 1998, and it plans on producing a total of 24 movies by the year 2000. At an average of 12 per year, starting in 1996, this is far less than the 25 to 30 movies released annually by the larger studios. But those large studios, while packed with talent, do not have the services of Spielberg, Katzenberg, Geffen or Bill Gates' Microsoft. DreamWorks Interactive will be housed both at DreamWorks SKG and at Microsoft in Washington state and will produce adventure games and interactive stories on multimedia software. According to a computer industry newsletter, the first DreamWorks Interactive Windows-based product will be on the market by December 1996. Spielberg's dream of total entertainment experimentation and control is on the brink of realization.

The incredible life story of a very interesting man has just begun a new chapter with DreamWorks. Movie-goers who have been charmed and entertained by Steven Spielberg in the past are anxiously awaiting the ride he will take them on in the future. It promises to be big and exciting yet have the special human touch of a very unique man.

u contributed by Michele Messenger

Software Trends

Computer software programs and applications, like the computers they run on, are becoming increasingly powerful and sophisticated, seemingly by the minute. New programming languages and advanced design methods are creating software far removed from the handful of rudimentary operating systems and crude applications that powered the first personal computers (PCs). Today, there are software applications that enable the use of technologies that were mere dreams just a few years ago. As these applications combine with such technologies as digital compression and high-capacity transmission networks, they shape the dynamic, interactive, interconnected world of the future.

Software Agents

The ever-increasing ways in which computers are used drive the demand for software that not only facilitates their operation but makes them easier to use as well. Graphical user interfaces (GUIs), such as the various versions of Microsoft Windows and the interface used on Apple's Macintosh systems, have long provided visually oriented, user-friendly interfaces between computer and user. Now, new applications are being developed that take the GUI idea one step further by using small programs, called "agents," that offer even easier ways to work with computers. In some programs, such as Microsoft's "Bob," these agents take the form of animated helpers that automatically offer assistance and advice to users as they perform various tasks on their computers.

Agent software, based on artificial intelligence technology, is structured so that the program "learns" how people work with their PCs. Agents are appearing more and more in software being developed for both business and home use. In addition to providing help, they can be used to automate simple, repetitive tasks, such as sorting to-do lists and E-mail. Eventually, agents in different applications will be able to work together, even acting as human surrogates in simple negotiations, such as confirming meetings, or as security gatekeepers for computers that are linked on local or wide area networks.

New input technologies

For years, devices such as keyboards and mice were the primary tools used for entering information into computers. Now, software allows computers to recognize data from other sources as well. Optical character recognition (OCR) programs convert information from scanners and electronic writing pads into editable text. Improved programming languages, coupled with today's more powerful computers and more sophisticated digital signal processors, are combining to make voice recognition programs a viable choice for anyone who cannot or does not want to use a traditional keyboard and mouse. These programs range from simple ones that allow verbal notetaking to programs that can translate words into computer code, allowing users to create documents ranging from letters to spreadsheets. Voice recognition software is increasingly being used to develop voice-activated services for telephone networks.

Multimedia

Audio, video, graphics, animation and text are being combined into media-rich software applications that are known as multimedia software. Computer games on cartridges and floppy disks were the first to utilize multimedia programming; the development of compact discs and digital compression allowed high-resolution, real-time graphics and video to be used to create the products that are opening up new worlds of entertainment and education.

Today, multimedia titles available on CD-ROM run the gamut from interactive dictionaries and encyclopedias (like this one) to challenging adventure games that include live-action sequences performed by well-known actors. Corporations are also beginning to use multimedia CD-ROMs to disseminate product information and develop retail sales catalogs, as well as to train staff and educate customers.

Multimedia applications can be either linear or interactive. Linear programs are similar to slide shows, limiting viewers to a straight-line progression of information screens. Other programs are interactive, allowing viewers to move freely through the information in the program in any direction. Special software programs, known as authoring systems, are available for home or business users wanting to develop their own multimedia titles.

Digital Compression

Digital compression, which shrinks audio and video signals by removing unnecessary data at regular intervals, enables large multimedia titles to be stored on CD-ROMs or transmitted over cable and telephone lines. Several compression technologies are currently used; however, new compression techniques promise improved audio and video quality as well as expanded storage capacity.

Interactive Games

Passive entertainment is quickly fading away as interactive games on CD-ROMs encourage users to become part of the show. Many of these games are based on popular movies, featuring live-action sequences that viewers can control. Although most interactive games are developed for teenagers, adult-oriented titles, offering complex, challenging games, are making their way into the marketplace as well.

Virtual Reality

The high cost of developing virtual reality systems, as well as the expensive technology necessary to create immersive virtual experiences, has primarily limited virtual reality's use to military training simulators, theme parks and video arcades. However, special 3-D glasses, joysticks and mice are now available that bring virtual worlds to the desktop. Today, would-be astronauts and other space travelers can experience outer space simulations in the privacy of their own homes. Desktop programs are now becoming available that allow home users to create their own virtual worlds.

Electronic Publishing

As printing costs continue to rise due to escalating paper and newsprint prices, publishers are increasingly offering books, educational texts, newspapers and magazines on CD-ROM or electronic networks. Electronic books now available range from best-sellers to reference works; many include additional source material as well as footnotes and indexes. Some are multimedia offerings including video clips, sound, and illustrations; magazines on disk often include multimedia ads as well.

Although many of these electronic offerings can be read on portable computers, complete desktop power is required to play more advanced multimedia titles. In the future, electronic books might take the form of hand-held computers about the size of a paperback that will play books contained on small memory chips or compact discs.

Virtual Libraries
A vast amount of information is now being stored on CD-ROM for access by computer networks, creating what are increasingly being referred to as virtual libraries. Although traditional paper-based libraries are not likely to disappear in the near future, these "libraries without walls" are becoming an integral component of library services as they augment on-site collections by offering access to information from a broader number of sources, as well as more timely delivery of this information to customers.

Virtual libraries range from electronic card catalogs and database search services that are now available at most public libraries, to specialized on-line services for both business and home users, offering access to information from newspapers, magazines, encyclopedias, rare books, databases and directories housed at libraries and other information storage facilities around the world.

Copyright/Intellectual Property Rights
The capability to make multiple digitized copies of materials and send them electronically to thousands of people almost instantaneously has fanned concern about the reliable protection of intellectual property. Current copyright laws do not specifically cover copyrighted material on-line. As a result, software developers and others are voicing their recommendations to the National Information Infrastructure's (NII) working group.

Proposals range from tight copyright control to exclusion of copyright law from the Internet. Librarians and scholars want the fair use principle upheld in the electronic environment, which would permit copying portions of protected materials for education, research, and the creation of new knowledge.

Until the law defines on-line copyright production, software developers who hold copyrights are using other means to protect their work. Some currently depend on contracts that define permissible use of copyrighted materials. Others employ transmission technology that requires specific software to descramble files. Some libraries deliberately downgrade the quality of on-line computer images in their collections, making them acceptable for academic but not commercial uses. Most CD-ROM titles allow text, pictures and audio to be copied for personal use.

u contributed by Sonia Weiss, with Nancy Muenker

Smart card

A slim, credit card-sized device containing a microprocessor and memory chips that enable it to store information. This information can then be read electronically by a computer for various types of electronic transactions.

For years, computer programmers have dreamed of ways to reduce the amount of paperwork created by common repetitive tasks. They pictured a computer processor that would be small enough to carry in a wallet but with enough memory to hold important information such as security codes, medical histories, financial data, and ID numbers.

Recently, devices like these have become feasible and are called smart cards. Smart cards are small, credit card-sized devices that contain a microprocessor and several memory chips. Each one can hold up to three pages of typewritten data.

These cards can be read by specialized electronic devices such as scanners and automated teller machines (ATMs). The information is read electronically off the card to a computer. The data can be then used and the smart card updated to reflect transactions.

Another application of smart cards is found in a computer security system. Often there is a requirement to access business computer systems from home, hotels or other businesses. One method of doing this is to have access via the public switched telephone network (PSTN) and modems. However, providing authorized access and preventing unauthorized access becomes a critical problem. Smart cards have been developed which have a very precise timer, a pseudo-random number generator, and a liquid crystal display (LCD). The card's electronics are synchronized with the computer system's access electronics. Authorized computer sign-on is simple: users just dial the proper telephone-modem number, sign on the computer and then enter the dozen or so digits as requested by the computer and as displayed on their smart card. In one system, for example, the number changes approximately every three seconds, and flashes for the last second. Attempted unauthorized access from hackers, competitors, or other persons attempting corporate espionage is effectively denied.

Smart cards are also ideal for repetitive tasks requiring set quantities of information that must be updated on a regular basis. Examples of their use include updating hospital records, and paying for automotive tolls and telephone calls.

Currently, the use of smart cards is limited by their memory capacity. But as memory storage requires less and less space, smart cards will continue to gain in usefulness.

u contributed by JDC Editorial Staff

Programming Languages

Programming languages are formal languages used to create detailed instructions that tell computers what to do.

A computer program is a list of precise statements of the actions a computer must follow to execute a certain task. These statements can be written in a number of ways by using programming languages, which describe the statements in language the computer can understand and execute.

Programming languages are often classified as being first-, second-, third-, fourth-, or sometimes fifth-generation languages, with each generation denoting an increasing level of sophistication and power. They are also classified by level. High-level languages, generally used today, closely resemble the English language and are the easiest for people to understand. Low-level languages, also known as machine languages, use binary numbers and are easiest for computers to understand.

Low-level languages were the first programming languages. These languages, which are native to all computers, use binary code strings of zeros and ones to represent internal switch settings that regulate the flow of energy into the computer's processors. Although machine language programs offer precise control over computer operations, they are cumbersome and time consuming to create. Because they are written in the computer's native language, a program written in machine language often cannot be used on computers with different processors.

Machine language was the only programming language available until the mid-1950's, when assembly languages were developed to address the complexity of writing machine language programs. Assembly languages simplified programming by giving each machine language instruction its own symbolic code. Special software, called assembler software, was used to translate the codes into language the computer could understand.

Since the 1950's, there have been numerous advances in programming language design, resulting in easier-to-use and more versatile languages. Dozens of different programming languages are available today for applications ranging from scientific compilation to desktop publishing.

Variations of early assembly languages are still used for some types of systems programming; however, they have largely been replaced by more sophisticated third- and fourth-generation programming languages. Also known as high-level and very high-level languages, these programming languages convert programs written in English into machine instructions by using language translators.

Although there are differences between programming languages, they also share many common characteristics and components. Each must allow for the transfer of data in and out of the computer. A method for representing and manipulating that data is also necessary. Finally, each programming language must address how the actual operations of the program are carried out.

Programs differ in how they treat and combine each of these components. For example, FORTRAN, the oldest high-level programming language and one of the first programming languages to gain widespread acceptance, was for a long time the dominant language for scientific applications. Because of its scientific orientation, it only supported two kinds of data, and its system operations only supported arithmetic and trigonometric computations.

C, and its variants, is one of the more popular languages that followed in FORTRAN’s path. This powerful, yet flexible language is often used for writing system and application software. Programs created with it can run on a number of different systems and support a variety of hardware platforms. Other popular programming languages such as COBOL and BASIC offer specific tools for designing business and educational programs.

New programming languages continue to be developed as faster, more powerful computers increase the demand for more sophisticated operating and applications programs. An example of these is object-oriented programming, which allows programs to be organized as a collection of objects, with each object containing program data and the commands to control the operation of that data. Also making their way into the programing language arena are fifth-generation languages, or natural languages, that resemble the English language.

u contributed by Sonia Weiss

Programming Languages, History and Development

Programming languages are special software programs used to create other software. Early programs used basic machine languages that were difficult for programmers to use and decipher. Over the years, these languages have evolved into sophisticated, yet understandable formats that often resemble the English language.

Early computers used a very basic language consisting of a binary alphabet (numbers zero and one) that told them what to do by controlling the flow of electrical current to the computer's circuits. This binary alphabet is also known as machine language. It is the native language of the computer and the only language that can be processed directly by a computer.

During the 1940's and early 1950's, machine languages were the only means available for communicating with computers. Machine language is extremely specific, and programs written using them gave programmers and computer operators close control over the computer's operations. However, the specificity of machine language also meant that programmers had to spend hundreds, if not thousands of hours writing programs that had to identify the specific storage location for each instruction and piece of data contained in the program. At the time, each computer processor also had its own language, which meant a program written for one computer system could not be used on another with a different processor.

By the mid-1950's new ways to write programs began to emerge. Simplified computer instructions, based on short symbolic codes, replaced the long strings of binary numbers that characterized machine language. These codes, such as A for Add, STO for Store, L for Load, and END for End, could now be used to identify each machine instruction. They comprised a new language, called assembly language. Special software, called assembler programs, enabled assembly language to work by translating the symbolic commands back into machine language.

Although assembly languages used computer resources more efficiently, they still had many of the drawbacks of earlier machine language programs. They were difficult to learn and use, and programs written in them were processor specific, making them difficult to transfer from one computer to another.

Programmers continued their efforts to design languages that would make programs easier to write. In the mid- to late-1950's, the first languages appeared that allowed programs to be written with regular words. These languages, called third-generation or high-level languages, combined words into statements that closely resembled sentences. A program translator or compiler then transferred the statements into machine language.

Third-generation languages were the first programming languages that could be used to write programs for more than one type of computer. This meant that programmers could spend less time writing separate operating systems for each type of computer, and more time developing software applications to meet the needs of the fast-growing computer industry. A number of high-level languages were developed during the 1960's and 1970's, including BASIC, COBOL, FORTRAN, C, and Pascal. Some of these languages, such as FORTRAN and COBOL, were primarily developed for specific applications, but many other third-generation languages were much more flexible, allowing their use for a variety of applications.

High-level languages were followed in the 1980's by fourth-generation languages. These languages differ from earlier levels by using different programming models. Unlike high-level languages, which separate the information the program works with from the procedures for manipulating that information, fourth-generation language programs combine both information and procedures into modules, or objects, that can be reused as units in other programs as well.

Very high-level languages require fewer lines of code, making software development faster and more efficient. However, they are often developed for specific applications, making them less flexible than third-generation languages. Often, programs written using very high-level languages require more processing power and time. For these reasons, third-generation languages are still the languages of choice for most software development today.

As faster, more powerful computers continue to be developed, the demand for more sophisticated programming languages to power those systems continues as well. Expanded ease of use will be a hallmark of these new languages, as evidenced by the new generation of programming languages currently being developed. These fifth-generation languages are sometimes called natural languages because they more closely resemble human communications. The more sophisticated fifth-generation languages allow commands to be executed in regular English, eliminating the need for writing even the simple programs required by fourth-generation languages.

u contributed by Sonia Weiss

Operating Systems: History and Development

The first computer operating systems (OS) were developed in the early 1950's to automate computer operations and make their use more efficient. Today, operating systems are essential to the operation of a computer.

Early computers were large mechanical devices designed to run a single program at a time. Programs and data were manually loaded by computer operators who operated switches or toggles on the front of each system. Once the computer was done processing, the switches were reset so that the results of the processing as well as the program itself could be unloaded. Every program written for these early systems also had to provide instructions telling the computer how to perform its operations.

These early computers were slow and difficult to operate, and their emphasis on manual operation required knowledge of the entire system. Because programs were loaded in sequence, these computers could manage only one function at a time, often spending more time sitting idle than working.

First operating systems

The advent of digital electronics made computers more complicated, and automating a number of functions became necessary in order to increase efficiency. In the early 1950's, computer scientists began developing programs, called operating systems, that allowed computers to operate without direct human supervision.

These early operating systems were simple programs that carried out the most basic activities, such as managing system resources, scheduling processing jobs and billing users. Each operating system had to be written in the machine's own language, using long strings of binary digits that could be processed directly by the computer's circuits. These programs gave precise control over the computer's operations, but they were difficult and slow to write. Since each processor had its own language, an operating system written for one machine could not be used by another.

More advanced programming languages developed in the mid-1950's addressed the complexity of writing operating system programs. Assembly language programs replaced the long binary strings of machine language programs with short symbolic codes, each controlling a specific machine language instruction. Translating programs, or assemblers, then converted the assembly language programs back into machine language that the computer could understand.

Because each line of code in an assembly language program controlled a specific machine language instruction, programs written in this language managed computer resources more efficiently. However, like programs written in machine language, assembly language programs related directly to a specific processor and could not be readily translated to other computers. Programmers still had to create machine-specific operating systems; a language that could create a program that would run on many different systems had yet to be developed.

High-level languages

During the late 1950's and early 1960's, high-level languages were designed that allowed programs to be written with English words that could then be combined into sentence-like statements. A program translator or compiler then translated the statements into machine language that the computer could understand. These newer, more flexible languages could be used for many different applications. Unlike earlier languages, they were not machine dependent, and programs written in them could be used on more than one machine.

Operating system programs written during this period introduced important concepts, such as time sharing, multiprogramming, virtual memory, sequential processing, and hierarchical filing systems. Many operating systems in use on large mainframes today are direct descendants of these early systems. UNIX, an operating system developed by AT&T in the late 1960's, is today gaining popularity for enabling applications programs to work across the full range of platforms, from microcomputers to supercomputers.

Operating systems at home

Computers began moving into the home during the mid-1970's. These early home systems were assembled from kits and could do little more than make the lights on the front of their boxes blink, but they were an instant success with electronics hobbyists and programmers. Few software programs were commercially available for these computers, which meant most owners of these early systems had to write their own programs, again in the simplest of machine languages. Basic operating system programs for these early home computers were eventually offered by their manufacturers, but many hobbyists still chose to write their own software.

All this changed in the early 1980's when IBM introduced its personal computer (PC), which came with its own operating system. Officials at IBM believed that the intended audience for the new machine would be more interested in using computers than in learning to program them. This meant that a standard operating system would be an important element to the computer’s success.

IBM first approached Gary Kildall, a computer scientist who had previously invented an operating system called CP/M, which could be easily modified to run on many different types of microcomputers. Eventually, a young company called Microsoft, co-founded by William "Bill" Gates, provided IBM with the Microsoft Disk Operating System (MS-DOS). It would ride the wave of the IBM PC's success to become the standard in the microcomputer operating system market.

Today, most computers come with an operating system already installed. Unlike early operating systems, often rife with programming errors that would cause them to falter or crash, these programs are solid, dependable performers capable of managing a variety of tasks. MS-DOS continues as the most common operating system. Windows, a graphic user interface (GUI) developed by Microsoft in the mid-1980's, is a popular add-on to DOS and is often used on newer PC's. Computers from Apple Computer Inc., including the current Macintosh line and all earlier Apple systems, all use a proprietary operating system that is unique to these systems.

Future operating systems

The continuing development of more powerful computers and the growing demands placed on those systems will drive the need for more sophisticated operating systems as well. Programs such as IBM's OS/2 and Microsoft's Windows NT are picking up where MS-DOS left off by offering functions that were not available in earlier systems, such as multi-tasking, virtual storage, and data compression. New programming methods, such as object-oriented programming, which combines data and instructions in single packages that can be reused and combined depending on the user's needs, will also have a strong influence on the operating systems of the future.

u contributed by Sonia Weiss

Operating Systems (OS): how they work

Operating systems are the brains of a computer. By translating user commands to language that the computer understands, they provide govern how computers work and oversee all computer operations. Without an operating system, a computer cannot function.

An operating system governs the way a computer receives and processes information. It automatically translates the instructions the computer receives into instructions the hardware can understand, coordinates all the resources of the computer system to execute the instructions, and then performs the desired task.

There are two basic kinds of operating systems. Portable, or open systems are found on most microcomputers; they provide a common platform for a variety of software applications. Proprietary systems, such as the one that powers Apple's Macintosh computers, only work with certain types of computers, and the applications software for these systems generally cannot be used on computers that use open systems.

Operating systems vary in structure and complexity depending on the type of computer being used and the demands placed on the operating system itself. Some are designed to run individual computers; others can operate numerous parallel processors at the same time. Some will only allow the use of one program at a time. Others can open multiple programs at once or run a network of computers using different programs.

All operating systems are composed of numerous layers of programming language, each adding new operations to the machine and hiding selected operations at lower levels. Each layer manages a set of software or hardware objects and defines the operations that can be carried out with those objects. This layered architecture, known as information hiding, eliminates the need for extensive reprogramming every time there is a hardware or software change by protecting the system components not affected by the changes.

At the top level of every operating system is the system's basic working environment, or interface, which determines how information is exchanged between computer and user. It is the only part of the operating system with which most computer users interact. Some operating systems have a graphic user interface (GUI), which employs icons and pull-down menus to guide users through the operations of the system. Others have command or text-driven interfaces that require memorizing text and command screens to perform tasks such as deleting and copying files and displaying directory and file lists.

Below the user interface layer are a number of specific programs and functions that govern how the system operates. System defaults establish standard instructions and formats that the computer follows unless otherwise instructed. Hardware resources are allocated and processing jobs scheduled by a supervisor program. A housekeeping program monitors the accuracy of input and output while checking for equipment malfunctions and program errors. Still another program manages computer files and allocates memory by controlling how disk space is used. At the lowest levels of the operating system are programs that manage the basic facilities needed to run software, such as the computer's electronic circuitry.

For these programs to work, the operating system must first be activated, or booted up. Most operating systems now start automatically when a computer is switched on. Some older computers might require manually loading the operating system by inserting a system diskette.

Once the computer is running, the operating system prepares the computer to accept and process information through the selection of a word or icon, or by typing in commands. Typing a command at the DOS or C> prompt to open a word processing package, for example, tells the operating system to locate the program in its memory and then enables the program to run. Clicking on a picture of a printer in an operating system using icons tells the system to perform the tasks necessary to produce a printed page with little or no additional information or commands from the user.

u contributed by Sonia Weiss

Object-oriented programming

Combines information and the computer's instructions for processing that information into one package. This package, called an object, can also be used to create new, related objects.

Most computer programming methods separate the data contained in the program from the steps the program will take to work with it. This requires separate programming to be developed for each possible action surrounding that data. Object-oriented programming (OOP) strives to eliminate this separation by creating packages, or "objects," that contain both the data and the procedures related to that data. By combining both elements into one package, OOP is said to resemble more closely how information is processed in the real world.

Objects created by OOP consist of programming code that combines data and instructions about the operations to be performed on that data. When the program references an object, it sends a message identifying what operation is to be performed. How it will be performed is already contained within the object itself.

These objects can be reused and plugged together in different combinations depending on the program's needs. They can also be used as the foundation for other objects with similar behaviors and characteristics. Objects used in this way are said to be a "class," meaning that they share specific information and instructions.

Further subgroups can also be built that contain the attributes of the parent class but also have characteristics of their own. Such passing down of similar traits through classes and subgroups is called "inheritance," and is a unique feature of OOP. Inheritance also allows automatic changes to all members of the class if modifications to the parent class are made.

OOP has met with mixed reviews, with some software programmers finding the reuse of existing objects more difficult than once believed. OOP programming methods can also initially be difficult for programmers to learn. However, OOP's underlying theories have proven to be sound, and elements of OOP continue to make their presence felt in software development.

u contributed by Sonia Weiss

Ohm, Georg Simon (1787 – 1854)

German physicist known for his experiments with electrical current and for the formulation of what became known as Ohm's law.

Ohm was born in Erlangen, Bavaria in 1787 and educated at that city's university. He began teaching mathematics at the Jesuits' College at Cologne in 1817, and resigned about 10 years later when his published research and theories were not well accepted there. He had correctly formulated the relationship between electric current, electromotive force, and circuit resistance. Now known as Ohm's law, this breakthrough greatly influenced the understanding and applications of current electricity.

Ohm joined the Polytechnic Institute of Nuremberg in 1833, serving as its director until 1849. During this time, his work gained wider recognition. The Royal Society in London awarded him the Copley Medal in 1841 and accepted him as a foreign member the next year. For the last few years of his life, he taught physics at the University of Munich. Georg Ohm died in Munich in 1854. The physical unit measuring electrical resistance, the ohm, is named for him.

u contributed by Kay S. Volkema

Murdoch, Keith Rupert (1931 –)

Australian-born American media giant whose News Corporation Limited owns Fox, Incorporated. Fox, Inc. is the parent of Fox Broadcasting Company (Fox), America's fourth national television network. Murdoch is the Chairman and Chief Executive Officer of News Corp. as well as Fox, Inc.

Murdoch was born in Australia, where his father, Keith, owned newspapers in Melbourne, Adelaide and Brisbane. When the elder Murdoch died in 1952, 21-year old Rupert left his studies at Oxford in England and returned to Australia to run the *Adelaide News and Sunday Mail*. From reporting to writing headlines to setting type, Murdoch was a hands-on owner who learned every aspect of the business. His efforts transformed the paper from being just marginally profitable into a huge hit. It was during his early days in Australia that Murdoch first found success with his bold, splashy style of reporting the news. Although blasted by critics, Murdoch's style won readership. And he persevered.

During the 1960's and 1970's, Murdoch continued to add to his media empire. By 1973 Murdoch controlled companies all over Australia, Great Britain and New Zealand. These companies included newspapers, magazines, television stations, radio stations, commercial printers and more.

In the mid 1970's, Murdoch moved his wife and children to the United States, and his expansion in American media started. By this time his newspaper style was very, very bold and splashy. And for the most part, very, very successful. Murdoch's name was synonymous with screaming headlines and sensational stories.

In 1979, Murdoch's Australia-based holding company, News Limited, changed its name to News Corporation Limited. In addition to this company, Murdoch controlled holding companies in England and the United States.

American network television held a special interest for Murdoch. True, a 1980 government report by the Federal Communications Commission (FCC) listed numerous reasons why a fourth television network would not or could not compete with the three established networks. However, apparently Rupert Murdoch never read that particular government report.

Murdoch sought a larger role in American media. In 1984, Murdoch bought, through News Corporation, 50% of Twentieth Century Fox Film Corporation. Within a few months Murdoch owned all of Twentieth Century Fox, purchased seven independent television stations and reorganized the entire company into Fox, Inc. Fox, Inc. had three distinct parts: a feature film studio, the television station group, and a television network. While assembling this powerhouse, however, Murdoch ran head-on into FCC regulations prohibiting a foreigner from directly owning more than 20%, or indirectly more than 25%, of a television station. Murdoch started the proceedings to become a naturalized citizen, and on September 4, 1985, he officially became an American.

The acquisition of the television stations was made by Murdoch's News America

Television, Inc., which is owned by Twentieth Holdings Corporation (THC). Murdoch controls 76% of THC stock; the remaining 24% is controlled by News Corporation, Murdoch's Australia-based company. That 24% would become the basis for Murdoch's ownership troubles in the 1990's. In November 1985, the FCC approved Murdoch's station ownership. Even though the FCC's unanimous approval was made with the full understanding of who and what owned News Corporation Limited and News America Television, Inc., some still questioned the foreign aspect well into the mid-1990's.

In the meantime, the recently purchased television stations became the foundation for the Fox Broadcasting Company, the new television network of Fox, Inc. Fox debuted in October 1986 with a late-night entry that failed. But Murdoch, with Fox executive Barry Diller and a staff of young, excited employees, brought the new network along and carefully crafted a market for it. By 1993, Fox was broadcasting seven full prime-time nights a week and was considered a legitimate network. Fox became known for young, hip programming that occasionally pushed the limits but seemed to shake up and wake up viewers and television executives alike.

Murdoch continued to acquire and build his worldwide companies. Once the Fox network was securely in place with prime-time programming, he was able to take more big steps: into sports, stronger programming and acquiring more affiliates.

In December 1993 Fox announced it had won broadcast rights to the National Football League's Sunday conference games. A major acquisition took place in May 1994, when News Corporation invested in a station group consisting of 12 affiliated television stations. All 12 became Fox affiliates, and the effect was felt all over the country as the other three broadcast networks scrambled to fill holes. Murdoch continued to surprise the industry as more stations were signed up. Broadcast and programming plans were announced, and Fox was ready to move into the fast lane of network television.

Murdoch continues to explore new opportunities through satellite television and on-line services. His network will eventually program day-time, late-night and news productions. And Murdoch, the aggressor in so many media endeavors, will have to start watching his rear-view mirror as new entrepreneurs, using Murdoch's strategy as a map, come up from behind.

Murdoch is said to be a gambler, a visionary, an extremist. After all, he envisioned himself with American media holdings, gambled on a fourth television network and took the extreme steps of buying large station groups and NFL broadcast rights. Whether gambler, visionary or extremist, Rupert Murdoch is always at the center of the action, leading the charge.

u contributed by Michele Messenger

Microwave System

Microwave systems use frequencies in the higher end of the radio spectrum to send television signals across long distances and to connect individual components of a cable system.

In cable systems, microwave systems facilitate the transfer of television signals from one point in the system to another. Off-air antennas and satellite dishes pick up television signals from broadcasters and satellites . But these receiving antennas are sometimes located several miles away from the headend in order to avoid interference from other signals in the area. The microwave system moves the signal from these remote antennas to the headend, where the signals are processed and passed along to customers. Microwaves are very high radio frequencies that are not likely to encounter interference from radio, television or other transmission signals in the area.

Microwaves are also used to send broadcast signals to areas that are out of the broadcaster's range. National television networks, for example, use microwave links to send programming to their local affiliates for distribution. Similarly, cable systems in major metropolitan areas may use microwave links to send local independent stations to more remote cable systems that cannot receive the station's signal with their off-air antennas. The remote cable system can then add this station in its subscription package.

u contributed by Christopher LaMorte

On-line Medical Support

The use of on-line technology by physicians and other medical service professionals to communicate with each other and patients on medical issues. Some examples include video conferencing on diagnosis and surgeries, sharing educational resources, on-line forums and mailing lists, and offsite training.

Up until recently, most American communities had a general practitioner and/or regional hospital. Unfortunately, many people living in isolated or rural towns are now losing their access to these services. There are a number of reasons for this change: many medical students are choosing specialized professions and settling in urban or suburban settings; the older doctors who served rural/isolated communities are retiring; and some regional hospitals aren't making enough money to remain profitable, so these facilities are closing their doors.

In the meantime, patients in these areas are driving farther and/or risking major health problems. The doctors responsible for their treatment are feeling the pinch. To solve this dilemma, both doctors and patients have been looking for other ways to support preventive health activities and treat medical problems.

With the evolution of the information superhighway, many health professionals started looking at ways to use on-line technology to help them treat patients. One of the first and still most commonly used applications is video conferencing between medical establishments. General practitioners can "meet" specialists over the phone lines using video and audio footage. Specialists get a chance to see the patient, hear from the presiding doctor the symptoms and attempted treatments, and give their diagnosis. Patients no longer have to drive to an urban setting to get a second opinion.

Unfortunately, the cost of the video conferencing equipment is quite high. Because connections between hospitals need to use a fast speed phone line, the medical establishments who could most benefit from telemedicine are also those least likely to be able to afford it. To make matters worse, insurance companies and many larger hospitals are uncomfortable with the idea of telemedicine. Neither is convinced that patients will accept it or that it truly does offer life-saving benefits. At this time, telemedicine is still considered experimental and it will probably take years before it is widely accepted by the medical establishment.

Doctors and patients also have access to a number of other on-line medical services. Until recently, for example, doctors have had to wait before finding out about new treatments and medications for illnesses. Their information options generally included attendance at conferences, reading medical journals, and receiving reports from the American Medical Association.

Now most physicians have access to on-line databases that can be quickly searched by the name of the ailment or other keyword. These databases are updated frequently and inform the doctor of new changes in treatment, medication, and dosage. But unlike other sources of information, the databases go several steps further. They also inform the doctor of previous side-effects, papers written on the treatment, and whom to contact for more information.

On-line databases frequently have areas where doctors can discuss topics, as well. These areas, known as forums, help keep medical professionals in touch with one another. This is especially important in research and experimental treatments where information gathered from multiple sources can aid in the development of a new medicine and/or treatment.

Patients can also gain a lot from on-line medical databases and forums. Most on-line services and the Internet have areas where members can discuss medical topics. Before this, patients had to rely on the doctor to provide them with information on their illness or local support groups for help. Many were uncomfortable talking with their doctor, or going to a place such as a counseling center where they might run into someone they knew.

But on-line support groups provide a place with relative anonymity. Patients can talk about their illness without worrying about being recognized. Most on-line support groups become more than a place to exchange information, often functioning as surrogate families where people can safely share their feelings and their lives.

Doctors are also noticing on-line patient support groups. Recent studies suggest that patients who know more about their illness and ways to combat it live longer and fuller lives. Consequently many medical professionals view these groups as another way to give patients more control over their health and bodies.

As innovative uses for on-line medical support will continue to develop, it is clear that this component of telemedicine will be an increasingly valuable tool to both health care providers and their patients.

u contributed by JDC Editorial Staff

Robotic Surgery

A surgical technology that uses a microrobot, equipped with light and cameras, placed inside a patient's body, to assist physicians by transmitting magnified images to a video console and executing a surgeon's commands.

Researchers at the Massachusetts Institute of Technology (MIT) Artificial Intelligence Laboratory are developing robotic surgery procedures that use microrobots equipped with light and cameras to assist physicians. The goal is a microrobot that can travel through a patient's bronchial tubes, digestive tract, ears or bloodstream and also one that surgeons can manipulate remotely. Possible means for placing the microrobot inside patients include ingestion, insertion or injection. Specifically, this project, funded by the Advance Research Project Agency (ARPA) of the Department of Defense, envisions the ability of U.S.-based physicians to guide microrobots to perform surgery on soldiers stationed throughout the world.

So far, MIT researchers have managed to create a microrobot that measures roughly one cubic inch and can be controlled by commands sent via computer. Two cameras mounted on the microrobot transmit magnified images to a video console. Viewing these images, the surgeon directs the microrobot's movements by manipulating surgical tools mounted on a computer console. For example, the surgeon may be able to have the microrobot take a tissue sample or use lasers to stop intestinal bleeding.

Before these functions can be viable, researchers need to reduce the microrobot's size. The MIT Laboratory eventually hopes to miniaturize the microrobot from one cubic inch to one cubic millimeter. Making it possible for the microrobot to move in the wet, elastic environments of intestines and bloodstreams is another major challenge. Nevertheless, several medical technology experts predict that physicians will be able to perform surgery using microrobots, ingested in pill form, by the year 2010.

u contributed by Nancy Muenker

Welch , John F. “Jack” Jr. (1935 -   )

American businessman, currently the Chairman and Chief Executive Officer (CEO) of General Electric (GE), the parent company of the National Broadcasting Company (NBC) television network.

In 1986 when General Electric, with Welch at the helm, bought the Radio Corporation of America (RCA), the then-parent of NBC, the ownership circle became complete. In the mid 1920’s GE and other companies (a consortium) established RCA in order to produce and sell radio sets. RCA, as manager of the consortium, then established NBC in order to provide programming for those radio sets. In the early 1930’s RCA bought out the consortium participants and was the sole owner of NBC until selling to GE in 1986.

Jack Welch, educated as a chemical engineer, started at GE in 1960. In 1972 he was elected Vice President, and in 1979 he was elected Vice Chairman. In 1981, when the company turned 103 years old, Welch became Chairman and CEO of GE. The company’s other business interests include engines, appliances, plastics, transportation services, lighting products, communications services, and financial services, among others.

Welch’s way of running a business is to face challenges head-on, an approach that has worked well for him at NBC. Perhaps his biggest challenge with the new company was financial accountability. In fact, when GE bought NBC in 1986, many NBC executives were concerned that its new owner was more concerned with cost-cutting than entertainment. However, Welch, as head of GE, was not alone. During 1985 and 1986, all three established broadcast television networks changed hands, and all of the new owners were very concerned with the lavish expenditures at the networks. The result was that all three companies went through many personnel changes, and some seasoned television executives were forced out or moved on.

Welch chose Robert C. Wright to become President and CEO of NBC on September 1, 1986. Wright came from GE, and Welch was confident he had picked the best person for the job. The two men were similar in their feelings about business and how NBC was to be managed.

Welch is a baseball fan and a Red Sox fanatic. During the 1986 World Series between the Boston Red Sox and the New York Mets, which was carried over his new network, NBC, Welch rooted for the Sox to win in six games. On the other hand, if the Mets won and the series went to a seventh game, Welch’s network would gain millions more in profits. Welch, who honestly felt he couldn’t lose either way, rooted for the Sox in six.

In *Industry Week* magazine’s 23rd Annual CEO Survey (1994), Jack Welch was voted to be the best and brightest among his peers. Welch’s fellow CEOs described him as “visionary,” “dedicated,” “a risk-taker,” “willing to change,” and someone who “empowers people.” Welch, who earned the nickname “Neutron Jack” when he significantly reduced the number of employees at GE in the early 1980s, has come around to a more people-oriented management style that insiders believe will pay off handsomely for GE as well as NBC.

With Wright capably looking after NBC and Welch overseeing Wright, NBC made it through the new-owner courtship and has continued to build its reputation for excellent programming and newscasts. During Welch's reign over the network, the industry has faced many changes and challenges. From new government rules to smaller audience shares, the established networks are persevering. Welch, along with Wright, plans to focus on and prepare for the future.

u contributed by Michele Messenger

Communication Satellites

Spacecrafts that orbit the earth, receive radio signals from the ground and redistribute them to various points across the planet.

Satellites are the "birds in the sky" that orbit the earth, receive signals from television programmers, and transmit these signals to many antennas on the earth. Most satellites have an average life span of 12 years. Usually, communication satellites orbit the earth in a geosynchronous position, which is 22,300 miles above the surface. A geosynchronous orbit allows the satellite to travel around the earth at the same rate the planet spins on its axis. This way, satellite antennas (called earth station antennas or satellite dishes) never lose contact with the satellite. Lower orbital positions are also possible. Medium-earth orbiting satellites (MEO) orbit at positions ranging from 621 to 18,641 miles above the earth; low-earth orbiting (LEO) satellites orbit anywhere from 186 to 559 miles above the earth. Because these lower-altitude satellites are not in sync with the earth's rotation, however, earth station antennas are only in contact with any one of them for only a portion of the day. To compensate for this limitation, MEO and LEO systems have multiple satellites in orbit. Although some communication companies are planning LEO satellite networks, most communication satellites in use today orbit in a geosynchronous position.

Geosynchronous satellites are used to beam television signals around the world. Some television networks like HBO, CNN and MTV are distributed exclusively by satellites. Broadcast television networks, such as ABC, NBC, CBS and FOX, use satellites to send programming to local affiliates. The affiliates then use broadcast antennas to distribute the network's signal to the local viewing area.

Often these television signals sent by satellites are scrambled or encoded in such a way that only those who have decoding equipment can correctly receive them. People who have a backyard satellite dish, for example, can pay a monthly fee to broadcasters (or companies that collect fees for a group of broadcasters) in order to lease a satellite decoder. Cable systems also receive some satellite signals that have been encoded. The cable operator decodes the signals before sending them to customers. Cable operators, however, scramble some signals again, such as those for premium channels, before sending them to customers. That way, only those cable customers that pay additional fees can receive these premium channels.

Direct broadcast satellite (DBS), a recent cable alternative, is becoming popular. Instead of beaming signals to satellite dishes that cable companies operate, direct broadcast satellites beam signals straight to consumers who have purchased small satellite dishes for their home television sets and pay monthly fees to a service provider. These dishes, measuring only about 18-inches in diameter, are much smaller than traditional satellite dishes, which may have a diameter of six or more feet.

Telephone companies also use satellites for long-distance communication. Before the first transatlantic fiber optic cable was deployed in the late-1980's, approximately 75 percent of international long-distance calls were linked through satellites. Today that figure has significantly decreased because of fiber optic cable’s ability to provide several million telephone circuits for overseas calls. Another benefit of fiber optic circuits is that they do not introduce echoes into conversations (unlike satellite transmissions). An echo is a phenomenon that can happen during satellite-linked telephone calls. It occurs when a speaker can hear his or her own voice as it’s being downlinked to the other party, which takes about a half-second. This echo makes it difficult to hold a conversation.

Though the importance of geosynchronous communication satellites in telephone communications has lessened, plans are underway to construct a global network of LEO communication satellites for mobile communications. Motorola’s Iridium project, for example, consists of 66 satellites orbiting 300 to 500 miles above the earth. This satellite network promises to link portable telephone users to each other and to other communication networks, allowing people to make and receive telephone calls from virtually anywhere on the planet. The portable phones used in the Iridium system would bypass Earth-based communication networks and send signals directly to satellites. The Iridium satellite that receives the signal would then relay it to another satellite in the network that would send the signal to the appropriate location back on Earth.

Other private enterprises have proposed similar LEO and MEO satellite networks that could handle voice, data and video information. Like Iridium, these projects are in their developmental stages but could be operational within 10 years.

u contributed by Christopher LaMorte

Charyk, Joseph Vincent (1920 –)

Canadian-born American aeronautical scientist and business executive who was responsible for maintaining a global network of commercial communications satellites after his 1963 appointment by President John F. Kennedy as the first president of Communications Satellite Corporation (COMSAT).

Joseph Vincent Charyk was born in Canmore, Alberta, on September 9, 1920, to John and Anna Dorosh Charyk. His father was a roadmaster for the Canadian Pacific Railroad. After graduating with a BS in engineering physics from the University of Alberta in 1942, Charyk came to the United States to study aeronautics under the Hungarian scientist Theodore von Karman at the California Institute of Technology (Cal Tech). In 1943 he obtained his MS and three years later his Ph.D., with honors, in aeronautics. His minor subjects were physics and mathematics. During his last year he was an instructor in aeronautics and an engineering section chief of the Jet Propulsion Laboratories (JPL) at Cal Tech.

In 1946 Charyk joined the faculty of Princeton University as a Professor of Aeronautics. He was attracted by the classically oriented institution's attempt to blend the sciences and the humanities. In 1948, he became a naturalized citizen, and he became an associate professor the next year. At Princeton he helped to establish the Guggenheim Jet Propulsion Center and the Forrestal Research Center.

Charyk became Director of the Aerophysics and Chemistry Laboratory of Lockheed Aircraft's Missile Systems Division in 1955, where he was involved with the beginnings of the Polaris Missile Program. A year later he and several other scientists broke away from Lockheed to form a new company, Systems Laboratories. Within months they were bought out by the Ford Motor Company, and the laboratories became part of Aeronutronic Systems, Inc., a Ford subsidiary. Aeronutronic then made Charyk Director of the Missile Technology Laboratory, and there he headed Project Far Side, a pre-Sputnik space exploration venture. In 1958, he became General Manager of the Space Technology Division.

Granted a leave of absence from Aeronutronic Systems, Charyk accepted a one-year appointment as Chief Scientist of the U. S. Air Force, beginning in January 1959. Later that year he was named Assistant Secretary of the Air Force for Research and Development and in January 1960, he was appointed Air Force Under Secretary, the number two civilian post in that service.

Meanwhile, the Kennedy administration had begun considering the establishment of a new kind of company to explore the possibilities for communications opened up by space technology. After much debate over whether the new enterprise should be government- or privately owned, competitive or government-regulated, Congress passed a compromise bill, the Communications Satellite Act of 1962. The legislation called for the incorporation of a privately owned, profit-making company that would nevertheless have close ties to the government. The corporation would work in cooperation with the U.S. Department of Defense and NASA, and the many unsettled questions about its future role would be decided by the Federal Communications Commission (FCC). Primarily a commercial enterprise empowered to sell its services to television networks, AT&T, and others in the communications industries, the new company was also envisioned by the lawmakers as an instrument of U. S. foreign policy and was required to make detailed annual reports to both Congress and the President on its operations.

The Communications Satellite Corporation, or COMSAT, was incorporated in February 1963. That month Charyk was chosen by President Kennedy to be President of the fledgling firm with Leo D. Welch as Chairman of the Board. Charyk was to be the Chief Operating Officer and technical expert, while Welch was to be Chief Executive Officer and financier. Both nominations were subsequently approved by the U.S. Senate. By June 1964, the new business was sufficiently organized so that its officers could offer up for sale to the public $100 million in stocks at $20 a share. Although Charyk and Welch warned that their venture carried great risks and would not be profitable for several years, the stock was snapped up within minutes on June 2, 1964. In keeping with the Communications Satellite Act, another $100 million of stock was sold to the communications industries, with the largest buyer, AT&T, gaining control of 28 percent of all shares. After all the stock was sold, the two classes of stockholders elected six directors each, and three Presidential appointees rounded out the board.

In July 1964, an 18-nation conference on interim arrangements to set up a global commercial communications satellite system was held in Washington, D.C. COMSAT was designated manager of the system, now known as the International Telecommunications Satellite Consortium, or INTELSAT, and initially was assigned 61 percent of the ownership allocation. (COMSAT was guaranteed that its holdings would never sink below 50.6 percent.) Any member of the International Telecommunications Union, which includes virtually every country in the world except China, can buy into INTELSAT or lease its facilities.

As COMSAT's top technical expert, Charyk bore chief responsibility for deciding what kind of satellite system to adopt. He considered principally three types. One was the random medium-altitude system, of which Telstar was an example. Such a system would require as many as 18 satellites orbiting at different altitudes with different movements. The second option was a controlled, moving medium-altitude system, which, like the first, would require many satellites. But the system that was finally decided upon required as few as three strategically positioned satellites to provide full global coverage. Each satellite would be launched into geosynchronous orbit, circling at a rate of speed that would keep it constantly positioned over the same spot as the Earth rotated on its axis.

The first satellite to be launched into geosynchronous orbit for COMSAT was Early Bird, which was launched from Cape Kennedy in April 1965 into orbit over the equator off the coast of Brazil. Charyk pronounced the satellite's performance letter perfect from launch to orbit, and within days the 85-pound satellite was in operation, transmitting international telephone calls across the Atlantic over its 240 voice channels. On May 2, 1965, its television services were spectacularly introduced with a live, hour-long cultural and educational program produced in cooperation with North American and European networks. Perhaps COMSAT's most spectacular accomplishment under Charyk's direction was the transmission of live television from the Apollo 11 moon landing in July 1969 to millions of TV sets around the world. But television transmission makes up only a small part of COMSAT's services. International telephone calls make up the bulk of its activity, while teletype messages, facsimiles (faxes), and computer data are also transmitted via its satellites.

In early 1965 the American Broadcasting Company (ABC) expressed interest in putting up a domestic satellite, but Charyk insisted that the Communications Satellite Act of 1962 granted COMSAT a monopoly on satellites in the United States, an interpretation of the law not shared by most experts. For several years the FCC postponed any decision on the matter, but in March 1970, it opened the field to bidding at the urging of President Richard M. Nixon. Although some 20 organizations expressed interest, only AT&T and the television networks were considered serious contenders along with COMSAT for such an enterprise.

Charyk was elected Chief Executive Officer of COMSAT on January 19, 1979 and served as Chairman of the Board of Directors from May 1983 until his retirement in October 1985. He continues to serve as a member of the Board of Directors of COMSAT and is a member of the Corporation of the Charles Stark Draper Laboratory, Inc. Charyk is the recipient of many awards, including the Arthur C. Clarke Award (1992), the Satellite Hall of Fame Award (1991), the National Medal of Technology (1987), the Theodore Von Karman Award (1977), the Television Arts and Sciences Directorate Award (1974), the Guglielmo Marconi International Award (1974), the Lloyd V. Berkner Space Utilization Award (1967), and the Distinguished Service Medal (1963).

The former COMSAT president has been described as a quiet but articulate man. He finds relaxation in golf and photography. Charyk is a member of the American Rocket Society, the International Academy of Astronautics, and Sigma Xi and is a fellow of the American Institute of Aeronautics and Astronautics. From 1954 to 1958 he was associate editor and the general editor of a 12-volume series entitled *High Speed Aerodynamics and Jet Propulsion.*

u contributed by Diana L. Hollenbeck

Microprocessor

Invented in 1971, a microprocessor is a type of integrated circuit that combines all the necessary components of a computer together on a tiny chip. A microprocessor may be programmed to operate a wide array of electronic machinery. Like any integrated circuit, it often is simply called a chip.

Practically every electronic device we use today contains a small computer called a microprocessor. Traffic lights, digital watches, personal computers, car engines, pocket calculators, and CD players are just some of the thousands of gadgets that have harnessed the microprocessor's power.

The history of the microprocessor begins in the late 1950's. That is when Jack Kilby, an engineer with Texas Instruments, developed an integrated circuit that reduced many cumbersome electronic components into one circuit. This integrated circuit (later known as a chip) triggered a downward spiral in the size and cost of electronics, as more and more components could be squeezed onto a chip.

In 1971, Marcian E. "Ted" Hoff of Intel designed an integrated circuit that contained all the components of a computer and could be programmed to perform a specific task or serve as a general purpose computer. Previously, integrated circuits had been built for a specific task; now, however, just one chip, called a microprocessor or central processing unit (CPU), could be used for numerous tasks.

The microprocessor's capacity is measured by the number of bits it can handle at one time. Early computers could access and move only a few bits of data at once. They had to repeat steps and cycle more than once in order to access and move larger groups of data such as a character or full bytes. To speed up this process, engineers designed methods to access and move larger groups of bits at one time. Currently, there are 4-bit, 8-bit, 16-bit and 32-bit chips. The last can handle about 4 million instructions per second. Intel is still a leader, along with Motorola, in microchip manufacturing. IBM computers run on Intel chips and Apple Macintosh computers run on Motorola chips. Computers are often described by the chip they contain, with larger numbers generally indicating faster computers. For instance the Intel 80486 chip (or 486, for short) is faster than the Intel 80386. Intel moved away from number designations for its chips when it introduced the Intel Pentium, the successor to the 486.

u contributed by Christopher LaMorte

Business Trends

With constant advancements in information technology, new approaches and applications are debuting daily. Companies are venturing into arenas traditionally outside their areas of expertise. Governments worldwide are striving to either expand or restrict information flow. And employers are finding additional ways to save money by equipping more of their workers with computers and other communication devices. The following are some of the major trends in business applications.

Baby Bells & Hollywood
The Baby Bells (regional Bell operating companies or RBOCs) are dressing up their plain old telephone service (POTS) images with Hollywood lights, cameras and action by embarking on joint ventures with movie production companies. Their objective is active participation in the video programming market.

The RBOCs plan to distribute movies and other programming over upgraded lines capable of carrying both video programs and telephone calls. Besides traditional video programming, they may also distribute travel assistance and educational shows, games, interactive shopping and banking channels, and movies on demand.

Eventually, the Baby Bells want to produce their own programming. Purchase of a studio, such as Metro-Goldwyn-Mayer, Inc., which reportedly is being prepared for a sale within three years, would give them immediate entry into movie production. Such a purchase would become even more attractive if the Baby Bells were permitted to distribute the video programs they produce within their own service territories. Although the Cable Communications Policy Act of 1984 prohibits them from doing so, industry observers expect Congress to lift the ban soon. Rather than wait, both U S WEST, Inc. and Bell Atlantic got the rule overturned in court and, as a result, are exempt from the Act.

Several Baby Bells have already begun readying themselves for Hollywood. U S WEST, Inc. gained access to film and cable production through its $2.5 billion investment in Time-Warner Entertainment. Bell Atlantic, NYNEX and Pacific Telesis Group are negotiating a joint venture with Michael S. Ovitz and his Creative Artists Agency, whose 900 clients include directors Steven Spielberg and Francis Ford Copolla. And Ameritech, BellSouth and Southwestern Bell (now SBC Communications) are having similar talks with Walt Disney Company to develop, market and deliver video programming to consumers.

Electronic Money
For years, businesses have used various forms of electronic commerce, such as automated teller machines, automated bill paying services, and on-line banking, stock trading and mutual fund investing. Now they are starting to accept transactions based on electronic money — the electronic equivalent of cash that can be loaded onto a hard drive or a wallet card and used freely and anonymously.

Today's closest equivalent to electronic cash in the United States is the smart card that carries specific, depletable dollar amounts on computer chips embedded in it. The most popular is the phone card, which holds a preset number of calling minutes. More than 1,000 U.S. companies, including Pepsi Cola and Ryder Truck, now give away phone cards as sales promotions. Sold at supermarkets and other convenient locations, these inexpensive, easy-to-use, disposable plastic cards are expected to attain sales of $850 million in 1995, doubling the previous year's revenues.

Whereas smart cards are limited to specific uses, cards for broader commercial applications also exist. For example, Mondex International, a joint venture of two British banks, issues digital cash cards to its bank customers. Similar to smart cards, they carry depletable balances. And, like cash, they do not identify the bearer or the financial institution. Customers electronically transfer money from their bank accounts onto these cards and then use them for purchases. At any time, merchants can bank their accumulated credits by phone.

Internet equivalents of electronic commerce also continue to grow. More than a dozen banks make it possible for their customers to transfer money and pay bills through Prodigy Services Corporation.

Concerned about protecting on-line transactions, several companies are striving to develop encryption technology. For example, Netscape, along with partners MasterCard, Bank of America and MCI, is building encryption and validation into its World Wide Web software.

If such efforts prove successful, paper, bond and coin exchange may become rare phenomena by the early twenty-first century. Instead, "cash" will be digitized certificates that individuals download from their banks and put in virtual wallets or on a motherboard chip to spend on-line.

National Information Infrastructure (NII)

Although American businesses have made strides to unite disparate technologies, multiple and unconnected webs currently form the United States' information network. Numerous wired and wireless connections link our homes and offices to telephone companies; cable television operators; Internet information services; electronic bulletin boards; local, metropolitan and wide area networks; paging systems; and other information providers.

Recognizing the growing need for an integrated electronic communications network, the Clinton administration has formulated a plan to create the National Information Infrastructure (NII). The administration envisions NII as "a seamless web of communications networks, computers, databases, and consumer electronics that will put vast amounts of information at users' fingertips."

The emerging consensus among business and government leaders endorses construction, operation and maintenance of the NII by the private sector, with government in a supporting role. Demonstrating support of cross-industry technical cooperation, about 30 major U.S. computer and telecommunications companies have formed a working team to develop NII standards and to share information and resources.

The government's key functions include funding research, leading experiments with ultra-high-speed networks, promoting standards, and protecting the democratic principles of private investment, fair competition and open access. Government projects, such as the National Research and Education Network (NREN), will provide a testbed for network standards and other technical advances proposed for the NII.

In the NII Agenda for Action, the government has outlined nine objectives that define its proactive responsibilities, in political, economic and social arenas, to ensure development of the National Information Infrastructure. Those that specifically encourage business involvement are: promote private sector investment; act as a catalyst to promote technological innovation and new applications; ensure information security and network reliability; improve management of the radio frequency spectrum; protect intellectual property rights; coordinate with other levels of government and with other nations; and provide access to government information and improve government procurement.

Both the public and private sectors will need to commit to constant focus, much experimentation, and concerted, cooperative efforts for the proposed National Information Infrastructure to become reality.

Telecommuting
Attracted by monetary savings gained from improved employee productivity, lower employee turnover, and reduction in real estate and other overhead costs, businesses increasingly are transforming office workers into telecommuters. John M. Nilles, author of *Making Telecommuting Happen: A Guide for Telemanagers and Telecommuters*, estimates that companies can save as much as $8,000 per telecommuting employee per year.

Companies that adopt telecommuting policies also enhance their corporate images. With a telecommuting work force, they help reduce air pollution and energy consumption, and they can more readily hire the disabled and other less mobile workers.

Technological advancements in computers, telephone services and telecommunications equipment have made telecommuting possible. Using messaging systems, facsimile (fax) machines, modems, palmtop and notebook computers, cellular telephones and other affordable and portable devices, workers can readily set up their offices at home or on the road. In addition, private networks connect employees' home offices so they can stay in constant contact with their companies' locations.

In 1993, more than seven and a half million U.S. employees (about six percent of the adult work force) telecommuted at least part of the week. Analysts predict that number will increase as much as 20 percent every year, more than doubling by the turn of this century. Preliminary findings of company savings, enhanced employee morale and increased productivity indicate that these predictions will hold true.

Transborder Data Flow
The term transborder data flow first emerged in the 1970's when multinational enterprises began connecting their locations within and among other countries to their headquarters via private data communication links. When firms also started marketing computer systems inside other countries, many governments became wary about dependence on foreign sources for information technology and implemented national policies that imposed restrictions on international data flow, imports of computer products, and foreign ownership of firms. As a result, multinational enterprises have found it difficult in many

countries to maintain private networks that ensure confidential corporate communications.

Enhanced transmission capabilities, however, have exponentially expanded the volume of transborder data flow in the 1990's, which has made governmental endeavors to control the flow and content of data increasingly difficult. For example, innumerable private citizens can now exchange information globally via the Internet. Satellite systems transmit signals to all points of the Earth's surface. And by the twenty-first century, individuals with personal communication service (PCS) handsets will be able to access databases from even the most remote areas worldwide.

Developments such as PCS, global satellite systems, and international video and broadcast programming demonstrate that the global thrust of information technology is fast, efficient and convenient communication from any point to any point. Transborder data flow now thrives on a global scale, facilitating ongoing growth in the number of corporations doing business around the world.

Video Conferencing

Companies increasingly use video conferencing to hold meetings among associates at different locations. By doing so, they increase productivity and save travel time and cost, yet still derive most of the communication benefits of "face-to-face" interaction.

Typically, video conferences have been held in large, specially-equipped meeting rooms. Now, however, associates can also conduct video conferences on personal computer screens. Many PC video conferencing packages let participants run Windows applications jointly and share files. On the computer's monitor, one window shows a video image of the individuals at the remote site. A second window serves as a whiteboard where associates interactively mark up a shared file, such as a document or graphic image. Some packages, however, limit video interaction either to viewing the other party or to working interactively with a document.

Popular applications for video conferencing include product design development, strategic market planning, and business proposal reviews. In addition, a major new market that is showing strong growth is non-traditional university education, whereby students attend classes held in distant campuses via their personal computers. This form of distance education is gaining widespread attention by corporations for its ability to deliver training and education to employees onsite.

u contributed by Nancy Muenker

Entertainment Trends

Information age technologies have long played major roles in the entertainment industry, but today these two arenas are converging like never before to create new forms of entertainment as well as new ways of delivering them. Technological advances, including increasingly faster, more powerful computers, digital compression, and high-speed digital transmission through large-capacity fiber optic cable systems, are enabling the creation of a plethora of entertainment options that grow by the minute. Increasingly, anything from the thrills of a lifetime to an on-line chat with a friend will be available through a click of a button. The age of digital entertainment has arrived.

The ways in which consumers access and enjoy these entertainment forms are rapidly changing as well. Video games, for example, are still manufactured on cartridges for play on specialized game systems connected to television sets. However, more video games are becoming available on CD-ROM discs for use on personal computers equipped with CD-ROM drives, sound cards, and advanced graphics capabilities. Those same computers can also be used to download from the Internet's World Wide Web an ever-increasing number of games that allow players to challenge the skills and gamesmanship of computers or other human players, or to create new games with multimedia authoring programs. Because most video games are already in digital format, they will be transmitted directly to home television sets that are equipped with special tuners and decoders that enable interactive play. Soon, new technology, such as that created by 3DO and other companies, will bring video games with movie-quality action to both computers and televisions.

Interactivity is the buzzword for today's entertainment industry, and faster, more powerful computers as well as improved communications networks are enabling the development of interactive applications that were but dreams in the minds of their developers just a few years ago. Interactive music video services currently available through cable and broadcast television will soon be accessible to desktop computer users through the Internet and other on-line services. Passive entertainment is fading away as interactive CD-ROM programs bring all the excitement of the big screen to home computers while encouraging users to become part of the entertainment. Publishing is going interactive as well, with new CD magazines and books complete with video clips and ads entering the marketplace.

With the addition of special equipment, such as 3-D glasses and simple data gloves to allow access to computer generated worlds, CD-ROM programs are starting to provide the ultimate interactive experience by bringing virtual reality games to the desktop. Today, would-be astronauts and other space travelers can experience a visual simulation of what it's like to float in space, whether in a virtual environment constructed at a theme or amusement park or in the privacy of their own homes. Soon, virtual reality experiences will join the wide range of interactive entertainment options that will be available through home television sets.

Nowhere are advances in interactive technology more eagerly anticipated than in the video broadcast industry. Because of the expense involved in developing interactive products, many developers are currently focusing the bulk of their efforts on applications for desktop computers; however, these applications will also be a part of the vast programming mix that will soon debut on the nation's television sets as well. Billions of dollars are being spent by such industry giants as American Telephone and Telegraph (AT&T), Time-Warner, U S WEST and Tele-Communications, Inc. (TCI) on the enabling technologies that will turn today's passive television broadcast system into a two-way, interactive information highway that will deliver all forms of digital entertainment to home viewers.

Interactive television, now being tested in a few markets across the United States, will transform the traditional one-way communications medium into a two-way system that can be used for anything from home banking and shopping to playing popular television games right along with the on-screen contestants. Video on demand (VOD), perhaps the most widely anticipated service envisioned for the information superhighway, promises access to vast libraries of movies, music, vintage television shows, educational videos and games. Interactive movies, currently being tested in specially equipped theaters, will encourage audience members to guide plot twists and conclusions by punching buttons on special joysticks.

The market demand for these new forms of entertainment now and in the future is driving a growing number of telecommunications, consumer electronics, entertainment and video-game companies to form alliances to offer new kinds of high-tech entertainment. Giant firms including Nintendo, Sega, NEC, Philips, Sony, IBM, and Apple Computer are already major forces in the interactive entertainment industry. More traditional entertainment and programming companies such as NBC, Time-Warner and Turner Broadcasting Systems have also entered the fray by offering on-line services and interactive CD-ROMs.

An increasing number of new partnerships between movie studios, authors, and video-game developers are developing as well, primarily fueled by the explosive growth of the video game industry in the early 1990's. Movies and television shows are being made with popular video game characters, and Hollywood's most creative talents are getting involved from the start when movie studios agree to license digital versions of popular movies. In fact, movies are now being shot with additional footage to make them more easily transferred to 3DO and CD-ROM game formats, and some movie scripts are reviewed for their video game potential even before the film is shot.

The future holds exciting promise for the digital entertainment industry. Increasingly powerful computer hardware and software will enable the development of more sophisticated interactive CD-ROMs and video games. Virtual reality experiences will become an even larger attraction both at theme parks and on desktop computers as the hardware necessary to provide immersive virtual experiences becomes more available and affordable. Continuing industry collaboration will drive the development of the networks necessary for broad delivery of such services as interactive television and video on demand. Consumers will have more choices for leisure-time entertainment than ever before. And, increasingly, those choices will be at their fingertips.

u contributed by Sonia Weiss

Education Trends

Asking for opinions about education is like asking what people think about religion or politics. Everyone has an opinion, usually strongly held, that may or may not be based on facts or knowledge. Today when new technologies are changing not only what is taught, but how it is taught, and sometimes not only who teaches it, but also "what" teaches it, these opinions are becoming even stronger. Following is an overview of a number of the most important trends in education today, including some diverse opinions about these trends.

General Education

Computers in the Classroom

In the 1970's and 1980's, bringing computers into the classroom was the rage. There were promises that computers would revolutionize the learning process. In actuality, many students only used a computer less than 30 minutes a week; probably a third worked with computers 15 minutes or less. And, when students did use them, the "revolutionary" programs they interacted with tended to be little more than drill-and-practice sessions that quickly lost their appeal to kids. Along with basic computer literacy, this was the extent of the exposure for a majority of students.

Even those teachers who were at first supportive of computer teaching found they didn't have the time, energy, correct equipment or knowledge to make effective use of computers. They also were disappointed in the drill-and-practice format of early programs, and began to use the programs less and less.

Administrators who had fought hard for computer funding began to see them as expensive boxes that became obsolete almost overnight; not surprisingly, many of the same administrators became gun-shy about spending any more money for the "latest and greatest" programs and hardware.

Software

Assessments of much of the software designed for teaching were not overly favorable either. According to the U.S. Office of Technology Assessment, there was "a general consensus that most software does not yet sufficiently exploit the capacity of the computer to enhance teaching and learning." The design flaws in most of the software usually stemmed from a lack of clear objectives. Even those that attempted to use good instructional technologies were usually relying on instructional designs that had been developed more than two decades earlier for a totally different media.

Interactive Multimedia

Into this scenario has stepped the interactive, multimedia technology of today. The claims being made and some of the programs being tested are truly amazing. But many parents, teachers and administrators are skeptical. There won't be any overnight changes and, as one insider puts it, the changes will probably be more evolutionary than revolutionary.

Accessibility and Affordability

Accessibility and affordability — two of the critical issues in educational technologies — have become especially important to America's rural schools. Not only are they isolated from other non-school sources of information, but they also generally lack basic equipment and have few teachers who understand the technology well enough to help their students use it in the classroom. Even the new technologies on the horizon may not be of much help to them because of inaccessibility. In addition, many telephone companies resist laying expensive fiber-optic lines in rural areas. And use of the Internet or similar services often incurs huge long-distance bills for rural schools because the nearest local access site is usually a toll call away.

Supporters and Detractors

Both sides of the question of whether schools should be wary of or embrace the new technologies have strong supporters. Langdon Winner, who teaches science and technology studies at Rensselaer Polytechnic Institute, bemoans the state of colleges and many college students who are computer — but not print — literate. Computer-savvy students are lacking basic literacy as more of the teaching comes in the form of multimedia and electronic resources, without the use of books. Financially strained universities, meanwhile, are substituting computer-based or videotaped lectures for professors, and many freshman and sophomore students in these classes seldom see or talk to the professor. Winner feels that much of the software currently available is providing only superficial treatment of many subjects. He says the term "virtual education" may actually be appropriate, since "virtual" is defined as "existing in effect but not actual fact."

On the other side of the argument are technology supporters like Lewis J. Perelman, whose book *School's Out* states that "hyperlearning" should replace traditional schools. He believes in high-tech, individualized learning that is ongoing for a lifetime and is demonstrated by competency rather than grades or degrees. Perelman's concept of hyperlearning involves any combination of learning tools and services, including computers, telecommunications, television, artificial intelligence and others, in whatever way is appropriate to impart the required knowledge or skill to the learner. He advocates that learning take place however it is best accomplished, whether individually at home or work, or networked throughout the world. With all that said, here are some of the major technological topics affecting education today.

Virtual Reality

In games and science fiction stories, virtual reality simulates physical experience through stereographic visual displays, tactile sensation and response to gestures. But virtual reality also plays a part in education, where the term "virtual" refers to "simulated" or "like." There are virtual libraries, which are networked sources of information accessible by computer from many locations and containing more sources of information than any one library could ever store. There are virtual classrooms, where students can follow a course of study either individually or networked with other students. There are even virtual colleges, where a student can take a series of classes taught entirely via computer networks or telecourses and without ever stepping into an actual classroom. Virtual reality training has already been used for years in simulated combat training, simulated pilot training, driver education, simulated auto crashes, and medical diagnoses.

More virtual environments are on the drawing board. The use of virtual reality in training has been well documented in the airline and medical industries. Unfortunately, these programs are expensive to create, and many educators worry that the substance may be lost in the glitz when they are created for the general education market. There are also many concerns about the loss of socialization and interaction that could occur with virtual reality training and education.

Multimedia

It is almost impossible today to buy a computer that does not have full multimedia features, including access ports for a telephone line and speakers. Many computers contain at least one CD-ROM drive and come with software for games and encyclopedias . In addition, many of today's monitors have better resolution than televisions. Along with the growing market for multimedia computers comes a similarly expanding demand for "edutainment" programs. In fact, the San Francisco brokerage firm of Volpe, Welty & Company forecasts that by the end of the decade, parents will be spending $1 billion a year on software for at-home learning programs.

What distinguishes these new forms of educational software from their predecessors is the interactivity involved. Until now, most educational programs were of the drill-and-practice variety. Interactive edutainment programs draw on their entertainment components to pull the learner in, and then often reward the learner with a game after the lesson at hand has been mastered .

Many education experts see interactive multimedia software as the key to revamping American education. They believe that the speed at which basic information is learned could be increased by 30 to 50 percent using multimedia programs, and that they could also be used to provide economical individualized instruction.

Obstacles to Multimedia in the Classroom

But actually integrating multimedia software into the schools, classrooms and curriculum in any significant way could take years. There are a number of obstacles to overcome. The first problem involves funding. Even though by now most schools have several computers, many of these are incapable of supporting the new multimedia software. And with school budgets already tight, convincing administrators to spring for more computers and upgraded software is no easy task. Then, there's the problem of how to integrate the new teaching method into the old curriculum. Some of the new software courses cross traditional boundaries either in terms of subject matter or age/grade plans. And teachers who got "burned" by the first round of educational software may be hesitant to attach much importance to this new group.

Some supporters believe their biggest help will come from parents who have seen the effect of edutainment programs on their kids at home. But this may only apply in more affluent school districts where having a home computer is common. These school districts tend to be more open and accepting of new material anyway, but what happens in the less affluent school districts?

Information Superhighway

If universally available and used correctly, the information superhighway could be a boon to education. High-speed, broadband networks would allow students from grade school to college to access abundant sources of information, whether in the form of library references, government studies, or live experts on a subject. It would also permit faculty, staff and administrators to share ideas, concerns and solutions to problems, and it would relieve the isolation felt by some rural or specialty teachers. Schools would be able to share resources, expanding their limited budgets by opening opportunities to students that they had previously only dreamed about. These resources could be computer programs, reference material, specialized teachers, or live discussions between students studying related subjects.

Changing Role of Teachers

As students learn to use on-line programs, teachers change roles from being the provider of information to being a resource and guide as students discover the knowledge for themselves. Educators know that students understand and remember what they have discovered for themselves far better than what they have simply been told.

Adult Education

In addition to benefiting elementary and secondary school students, the information superhighway could have a profound effect on adult education. When education becomes more convenient, more people will take advantage of it. College students could take courses at the time and in the place that best suits their schedules. Workers could increase their education and knowledge from the office or at home. Professionals could quickly and easily keep up with the latest findings in their fields.

Again, the problem with achieving this dream will probably be funding. Obsolete computers must be replaced and teachers must be trained to use the information superhighway. Nothing is more frustrating and detrimental to the use of a new technology than being unable to use it correctly. Communities, educators and information providers must make the commitment, both in terms of money and time, to make the information superhighway work for them.

In the Business Environment

Use of the information superhighway for professional or corporate training is occurring more rapidly than for public schools. Many corporations see the financial benefits of holding training sessions over a broadband network rather than having employees travel to a training center. Plus, private enterprises usually don't have the budget limitations and other financial obstacles that face public education. Some corporations have even been willing to help fund the use of the information superhighway for colleges and universities from whom they draw potential employees.

Distance Education

The concept of distance education has been around for a long time. Colleges have offered correspondence-type courses to students; Australia has a long history of educating children in the outback via two-way radio, mail-in lessons and parental supervision of work; cable television companies have added educational channels, like Jones Intercable's Mind Extension University, that allow working adults to add to or complete their education during their leisure hours; and universities have networked some of their basic classes for students at various campuses to complete by watching televised versions of the live classroom lecture in remote classrooms or their own dorm rooms.

Distance education is now ready to move beyond these simple approaches to much more complex situations. The costs of print-based instruction and formal school environments are rising, whereas the costs of telecommunications are falling. The climate is right for the increased use of telecommunications-based education, and most states already are involved in some forms of distance education. Unfortunately, there are no agreed-upon standards for distance education programs that would help make compatible national distribution available. And, although the long-term economic benefits are well-understood, it takes immediate funding to set up distance learning environments. Some public and private schools are getting help from corporations or private agencies. Some government funding is available as well, but the process will take some time to evolve.

Use by Corporations

Once again, corporations see the value in distance education for their employees. Even major undertakings, like Ford Motor Company's proposed satellite network for its 6,000 dealerships, will pay off in the long run, when training can be completed immediately and without the travel expenses normally incurred. As many corporations move into international business, they link their various locations with private or leased satellite communications.

Use at Universities and Colleges

Universities and colleges are beginning to follow suit. Through fiber-optic cabling and leased satellite communications, they are able to connect with other universities throughout the world, as well as with local secondary and elementary schools. This allows students at all levels to enhance their learning opportunities without the schools themselves having to provide additional classrooms, professors, or materials.

Help for Rural Schools

Rural schools, often without access to fiber-optics or satellites and with limited budgets, are making use of advanced digital technology to interconnect schools through inexpensive telephone lines. These lines can be used to provide video conferencing and collaborative multimedia computing, and open up avenues never before available to isolated students, teachers and administrators. Many educators see these links to rural schools as a major step in achieving equity in the classroom with suburban or urban schools.

National Information Infrastructure (NII)

NII refers to the national information superhighway proposed by the Clinton administration. Its most vocal supporter is Vice President Al Gore, whose goal is to connect every classroom, library, workplace, community center and home by the year 2000. The NII would give millions of Americans national access to voice, data, full-motion video and multimedia information and applications. Since knowledge is what drives today's marketplace, the NII would allow users to take learning beyond the limitations of traditional school buildings or corporate training centers.

Vice President Gore, representing the views of many educators as well as the Clinton administration, believes that to reach the full benefit of the information age in which we now live, high-speed networks must be developed to tie together the millions of computers that currently reside in businesses, schools, libraries and government offices. The interactive capabilities of the NII will have the same type of impact on education in the twenty-first century as printed books did in the eighteenth century; in other words, bringing information to everyone, not just an elite few.

Current Telecommunications Infrastructure

The current telecommunications infrastructure is composed of telephone, broadcast, cable

and electronic networks. These networks supply education and training in five basic ways:
1) instructing with video;
2) accessing information from on-line libraries and databases;
3) communicating through E-mail and bulletin board services (BBS);
4) providing telecourses for distance learning; and
5) facilitating electronic transfer of instructional software and simulations.
Even though this list sounds impressive, many of the existing capabilities are not being fully utilized because of outdated computer equipment, inadequate transmission lines, and ineffective training.

Costs of the NII

The goals of the NII are lofty, and the costs are high. For example, estimates place the cost of connecting fiber-optic cable to every home, office, factory, school, library and hospital at more than $100 billion. And many of the private companies who would lead the charge, that is, telephone and cable television companies, are expending their efforts in competition for each other's business rather than wiring the nation for the NII. Meanwhile, many businesses and some schools are turning to satellite or other wireless networks to meet their own needs.

Standardizing the NII

An analogy to the interstate highway system is frequently used when describing the need for the NII. If each person built his or her own road, using individual standards and materials, the roads wouldn't match up. The driver probably couldn't travel from here to there without stopping to change or refit the vehicle. The traveler might also have to alter the speed or change which lane the car was being driven in; and since the signposts would be different, the driver might not recognize the exit when it appeared. This is the situation facing the nation with the information superhighway.

The road problem in the United States was solved by a standardized interstate highway system that made it possible to travel easily from one coast to another. The same sort of standardization needs to take place within the NII so that users will be able to get from here to there. Vice President Gore feels that it is up to federal and state policymakers to determine how best to build a universal, high-speed network, to reconcile the competing corporate interests and to create a network that will be usable by all Americans. In addition, with the globalization of information, whatever network is used in the United States must be compatible with networks being developed in other parts of the world.

Making the NII User Friendly

Another challenge for the NII is to make it user friendly. The current Internet is certainly not for the technology beginner. And, although many on-line systems appear simple enough when first accessed, they can be frustrating and perplexing for many computer novices. It's been said that every piece of information you might want (or someone who can get it for you) is on the Internet. All you have to do is find it. But often it takes a lot of patience and hours of experience to "surf the Net" successfully. Consequently, information access must be made easier, simpler and more timely for the vast majority of Americans to use it efficiently.

In addition, the information that will be distributed across the network must be developed. Much of the training and education pieces that are currently available don't live up to the full potential of the medium. Many educators, corporate trainers and course developers need to learn how to use, support and develop their own programs to maximize the learning media they will have at their disposal. If the training and educational pieces become mere electronic page turners, users will become bored and discouraged and will stop using the service.

Making the NII Affordable

Lastly, this service must be affordable for everyone. Telephone and cable companies have separately promoted special deals for schools. But providing access is one thing; it's quite another to actually provide the schools with toll-free network nodes and telephone jacks in every classroom. Unless virtually all schools can afford to participate, the gap between the information "haves" and "have nots" will only increase. Public interest groups are trying to force telecommunications companies to provide free or inexpensive network connections and usage to schools and other public institutions. Many companies and industries are already beginning this task on their own.

A provision in proposed communications legislation in 1994 would have required all telecommunications carriers to provide educational institutions with interstate and intrastate access services at preferential rates. The bill also would have required that all public elementary and secondary school classrooms and libraries have access to advanced telecommunications services. Although passed by the House of Representatives, this legislation did not make it through the Senate. Nevertheless, insiders believe that major telecommunication reforms are inevitable, and they hope that on-line access to all schools and libraries will be part of that reform.

Summary

Radical educational changes are coming. The computer and telecommunications technologies are converging and will impact access to information in ways never believed possible. These technologies must be embraced, researched and understood by educators so that they can be effectively employed in schools and businesses. Change is never easy, and changing something as institutionalized as our school systems will not happen quickly. But change will occur. Computers and on-line networks will change how students and teachers locate and use information. Multimedia and virtual reality will change learning processes. And the NII (and eventually the Global Information Infrastructure) will make access available to everyone. But it won't be quick and it won't be easy. It will likely take 20 years before the use of this new education technology becomes widespread.

u contributed by Linda Stranahan

Personal Application Trends

Watching a television program, talking on the telephone, copying a magazine article at the library, or "chatting" on-line all appear to be inconsequential, everyday activities. Yet, each one evolved from extensive technological development and continues to create on-going research and debate about regulation, competition and rights. The following are trends in addressing some of the major issues that personally affect general consumers.

Copyright/Intellectual Property Rights

People are accustomed to leafing through publications at a bookstore or magazine stand before deciding whether to purchase them. Copyright law permits this free review of protected materials under the "first sale" doctrine. People also make photocopies of parts of books or articles at their local libraries. In this case, copyright law's "fair use" principle, which allows copying of portions of protected materials for comment, education and research, applies.

"First sale," "fair use," and other provisions of free access to information that have worked effectively in the print world, however, may be curtailed in the electronic world. In fact, some publishers, software developers and other groups are promoting stricter copyright and intellectual property rights laws to protect on-line publications, products and entertainment. Their position has resulted primarily from the costly piracy of software, which caused a loss of more than $2 billion in the U.S. software industry in 1993. Likewise, digital manipulation of materials and the ease with which thousands of copies of a document can now be sent to people worldwide almost instantaneously have fueled their concerns.

Publishers and developers are seeking ways to protect the works they have placed on electronic networks and to ensure fair compensation for their use. Measures may include the use of technologies that transmit material electronically in a scrambled format that requires special software to unscramble (much like cable operators use to prevent non-subscribers with satellite dishes from viewing their programs) or the use of metering devices that track what each user reads or prints, with royalty fees collected accordingly.

Some institutions have already taken measures to protect on-line copyrighted works so that the "fair use" principle will still be applicable in electronic environments. Some libraries, for example, are deliberately downgrading the quality of the on-line computer images in their collections. In this manner, the images are acceptable to researchers but commercially useless to pirates.

Debate over how copyright and intellectual property rights laws should be applied to electronic content will continue for many years. This debate will be especially critical in international markets, where piracy issues are even now having a serious impact on U.S. trade negotiations with several major trading partners. On the home front, however, the key consideration will be how and when consumers pay to use copyrighted material, print or electronic.

Electronic Democracy

As envisioned by its proponents, electronic democracy is universal and affordable access to the electronic information network and the protection of the U.S. Constitutional rights of free speech, free assembly and privacy of individuals in the electronic arena. As simple and straightforward as electronic democracy may seem, creating an infrastructure that is available to all and applying Constitutional rights in an electronic community that has no boundaries and is filled with anonymous citizens is a major undertaking.

Potential benefits of electronic democracy, however, spur developers of the National Information Infrastructure (NII) and other groups to move forward. Many view electronic democracy as a means for more direct participation of citizens in the political process, especially through electronic voting. Voters are increasingly expressing interest in referendums that let citizens, rather than their legislative representatives, determine tax levies and other issues. In fact, more state initiatives and referendums occurred in the 1994 election period than in any year since 1932.

The electronic community also provides a means for individuals who share a specific political position to find each other more easily, to “assemble” and to take action as a group. So, even though individuals may not find others in their geographic community who support their issue, they may encounter one or two people in hundreds of other communities who do. With them, they can form a sizable coalition that ensures legislators’ attention.

The perceived benefits of electronic democracy, however, also carry potential drawbacks. Key among them is voting fraud. To minimize its incidence, protective measures, such as national identification “cards,” would need to be used. A voter, for example, might be verified by means of a face scan, voice graph, fingerprint scan or other technological method. Some fear that such protective measures could lead to the spread of government surveillance into unjustified areas as well as the abuse of privacy and other Constitutional rights.

But before electronic voting and other widespread participatory activities can occur, society must address the question of universal access. Who is entitled to use the information network and at what price? Who will pay the cost (about $1,500 per home) of extending access to remote areas and to the poor? The debate over universal access is underway in both the physical and electronic communities; those who want to participate in the “electronic democracy” are starting now by letting their “voices” be heard.

Electronic Money

In the 21st century, instead of pulling dollar bills or coins out of their wallets to pay for purchases, consumers may take out a plastic card that contains electronic cash on an embedded microchip. Each transaction — gassing up the car, buying milk and eggs, renting a video — decreases the card’s balance, much like breaking a $20 bill for a series of purchases. And, like making a deposit to one’s bank account, the owner can replenish the card’s balance before it hits zero.

These plastic cards embedded with microchip cash are electronic money, also called digital cash, cybermoney, and electronic cash. Like dollar bills and coins, these cards can be used freely and anonymously. Unlike credit cards, they do not bear the owner’s or the financial institution’s name. So if they are lost or stolen, one has no recourse. In Great Britain, Modex International bank customers have begun transferring money from their accounts onto digital cash cards that they then use to make purchases. They also can use the cards to make transactions with other individuals. For example, they can buy a neighbor's lawn mower with electronic money by using specially-equipped British Telecom telephones.

True electronic cash cards are not marketed yet in the United States. Their use probably will be delayed until the process of transferring one's funds onto digital cash cards or certificates can be adequately protected from fraud. In fact, a number of companies are developing encryption technology to counteract this type of fraud, counterfeiting, and invasion of financial privacy.

Smart cards, however, are growing in popularity. They, too, carry specific, depletable dollar amounts on computer chips, but their use is restricted to a specific application. Phone cards, for example, carry a set number of calling minutes. Highway toll cards affixed to windshields make it possible for commuters to drive through toll booths a set number of times without stopping. And newspaper readers can insert kiosk cards to pay for their favorite publications.

Eventually, U.S. consumers will be able to transfer funds from their banks onto digital wallet cards for marketplace purchases or onto their computers for on-line spending.

National Information Infrastructure (NII)

The overall purpose of the National Information Infrastructure (NII) is to provide citizens with affordable, open access to on-line information. As envisioned by the Clinton administration's Agenda for Action, the NII is "a seamless web of communications networks, computers, databases, and consumer electronics that will put vast amounts of information at users' fingertips." Such a seamless information network potentially offers three major benefits to our society: flexible employment, targeted education, and intelligent health care.

Flexible employment would result from information workers telecommuting to their jobs via computers, modems, facsimile machines, telephones and similar equipment. For many individuals, being able to work in one's home would expand the range of available job opportunities. About six percent of the U.S. adult work force now telecommutes at least part of the week. The NII would help this trend grow.

Targeted education would enhance the opportunity for citizens to learn, regardless of where they lived or the resources available in their local communities. With the NII, as long as individuals had access to a network-linked computer at home, in a town library, or other nearby location, they could "attend classes" conducted in remote classrooms. Thus, even though the nearest community college or general education development (GED) program might be hundreds of miles away, people would be able to pursue their educational interests.

Lastly, the NII agenda would promote intelligent health care achieved through on-line access to expert medical resources. Again, geographic distance or lack of mobility would not limit citizens from obtaining relevant information. The NII agenda is based on the assumption that timely answers to citizens' health questions and concerns will help preventive health care prevail.

Federal Communications Commission (FCC) Regulation/Deregulation

The results of the Federal Communications Commission's (FCC's) regulatory functions over communications services touch our lives every day. For instance, the FCC issues broadcast licenses to radio and television stations. It determines under what conditions cable operators can increase their basic rates and by how much. And it decides which companies will be able to send video signals into our homes over telephone wires.

Perhaps the best recent example of the FCC's role and responsibilities is its decision about how to allocate frequencies of the electromagnetic spectrum for the emerging personal communications services (PCS) technology. After hearing the position statements of industry lobbyists, government entities, special interest groups and citizen advocates, the FCC chose to configure the PCS allocation so that each town and city in the United States could have up to seven PCS licenses, broken up into 10 MHz, 20 MHz and 30 MHz blocks.

For every person who lauds this decision, at least one opposes it. Underlying the FCC's decision was the intent to create a competitive market in which consumers would find a number of options. The variety of block sizes would make it possible for small companies to compete while also offering sizable blocks commercially attractive to large providers. In essence, this independent government agency had to address the needs of companies that are investing billions of dollars to develop the PCS infrastructure (the highest single bid at a PCS auction was more than $2 billion) while also ensuring fair, broad-based competition and consumer protection.

Currently, many are debating whether the FCC is needed in today's increasingly competitive communications marketplace. Some say competition will impose the disciplines that regulation has been exacting. Others express concern that without regulation large companies and consortiums will control the market, forcing emerging firms out of the arena. And others question whether an unregulated market will provide the general public with adequate access to critical services.

Smart Homes

Lights go on when dusk falls, the heater kicks on at dawn, and the clothes dryer begins spinning when utility rates hit off-peak hours. These automated features join numerous others available with "smart home" systems.

Standard lighting and temperature control systems have been available since the late 1970's. Using the conventional X-10 standard, they superimpose control signals over a home's existing electrical wiring. Builders and utility companies, however, envisioned an integrated network whose central computer would pipe electrical, video and phone signals over special wiring into any wall socket to control products designed especially for it. In the early 1990's, 36 American companies created Smart House LP to develop the technology.

Subsequently, other groups have created standards for systems controlled by microchips embedded in appliances instead of by a centralized control unit. The advantage of automated networks based on Echelon's Neuron chips or the Electronic Industries Association's (EIA) CEBus microchips is their ability to use sensors, switches, appliances and other devices produced by any number of manufacturers. Also, because they do not require special wiring, existing homes can be retrofitted. And these modular systems give consumers the added benefit of being able to add more appliances as their budgets allow.

Prices for automated environments run about $1,000 for centralized, programmable lighting and temperature control systems and from $4,000 to $100,000 for integrated home automation networks. A Smart House system for a 2,500-square-foot home, for example, costs up to $15,000 installed. IntelliNet and other systems that include audio, video, mood lighting, security, and sensor-triggered HVAC controls cost around $25,000. Prices soar with the addition of driveway sensors that announce the arrival of a car, showers that turn on automatically and other luxury items.

Despite the general public's increasing ease with technological gadgetry, the market for automated home environments is small. In fact, industry watchers predict that only two million American homes will have automated systems in the year 2000. Cost seems to be the primary deterrent: surveys show that $700 is the maximum that most consumers want to pay for a system. And, for the most part, people want easy-to-use practical systems that save time and money. Programmable mood lighting is not high on their list. Also slowing down acceptance are the industry's competing standards. For the foreseeable future, home automation systems will not be a mainstream product.

Standards

In order to ensure consistency of quality and compatibility, organizations have determined standards for products and services in practically every industry, from the film one buys for a vacation trip to the technology that transmits video programs over direct broadcast satellite (DBS) systems. Without industry standards or with more than one available, consumers experience confusion and frustration. During the market battle between Beta and VHS, for example, buyers hesitated to purchase VCRs for fear their choice would not end up the survivor. Likewise, many people have adopted a wait-and-see attitude towards digital cellular telephones and similar communications until a given technology not only wins the vote of a standards organization but also prevails in the market place.

Both industries and government are working towards setting standards earlier in the technological development process. The International Organization for Standardization - International Electrotechnical Commission (ISO-IEC), for example, has produced a standard called MPEG-2 for digital video compression technology that all DBS suppliers in the United States have adopted for their systems. Anticipating the need for end-to-end compatibility of video-on-demand (VOD) systems, expected to be a major growth area for cable operators, the ISO-IEC is also in the process of producing a VOD system standard.

On an even more complex level, the information highway needs standards to interlink its numerous networks and to create a seamless system both nationally and globally. To address this issue, the American National Standards Institute (ANSI) formed the Information Infrastructure Standards Panel (IISP) in 1994 to promote development of standards necessary to support the National Information Infrastructure (NII).

For individuals investing in products and services to explore the information highway, these industry and government efforts to develop standards will help minimize the complexity and anxiety of purchase decisions.

u contributed by Nancy Muenker

Medical Trends

Technology is not only changing the telecommunications industries, it is changing the field of medicine as well. Here is a brief overview of some developing medical technologies using telemedicine, robotic surgery, virtual reality, on-line databases and forums, and neural networks that are benefiting patients and doctors alike.

Virtual Reality
Until recently, doctors in training frequently had to practice new techniques on real patients. For some delicate procedures, they would learn on cadavers or a piece of fruit. The results were less than spectacular. Living patients often complained that they were being used as guinea pigs. Other methods did not give accurate feedback to the trainees, so they had little idea if the procedure was being done correctly.

But medical training today is going through a series of dramatic changes. Perhaps the most important change is the use of virtual reality (VR). VR simulates a real-life environment using computer-generated animation, video goggles, and sensorial gloves. The user feels as if he or she is inside the machine, and can hear, feel, and respond to the virtual environment.

VR allows the doctor in training to perform delicate surgeries and procedures on a virtual patient that will react in the same way a real one would. If a mistake is made, the VR patient will die or experience some other serious complication. Some VR programs let the patient ask questions and make typical human remarks such as Do you know what you are doing?

The best part of VR training is that the student doctor can go back time after time to see what mistakes were made. The trainee may also return to the same procedure repeatedly until mastering the technique without the risk of hurting a live patient.

VR technology is still in its early stages, and the costs for a single machine can be very high. In addition, the technology is slow and hard to navigate. But this is quickly changing. As more and more users find ways to incorporate VR into their work environment, the costs will go down. By the year 2000 it probably will be a standard part of medical curriculum.

Telemedicine
Used most often in rural settings where there may be few doctors per community or region, telemedicine involves the use of video conferencing for medical treatment and analysis. The local physician, for example, arranges a consultation with a specialist at another hospital. They speak using a computer connected to a video camera and microphone. The conference occurs in real time, meaning that both doctors can speak and react to each other at the same time.

While telemedicine has shown a number of benefits, many hospitals, doctors and insurance companies are uncomfortable with the new technology. The hospitals and physicians are unsure that their patients will feel comfortable talking with another doctor hundreds or thousands of miles away. Insurance companies, on the other hand, do not feel that the technology is worth the price. So far, telemedicine is considered experimental.

The age and size of the world's population is increasing while the number of doctors, especially general practitioners, is declining. So, as time goes on and medical resources become more scarce, telemedicine will probably become a more accepted part of medical treatment. Telemedicine will allow doctors to help more patients while keeping many of them in or near their homes instead of in the hospital.

Eventually telemedicine could expand *into* the homes of patients, as well. As the cost goes down, patients who at this time would need to be monitored in a hospital, could stay at home instead and check with their physicians using video conferencing on a daily basis. The doctor would be able to actually view the patient, make sure no complications had arisen, and talk with the patient and other family members about his/her condition.

Robotic Surgery

Robotic surgery lets the surgeon in charge operate on a patient using a robotic arm or other instruments. Using telemedicine, the surgeon may be on-location or remote from it. As with other telemedicine techniques, robotic surgery is still considered experimental. Most insurance companies and hospitals are reluctant to try the technology for fear of how the patient will react to it.

Robotic surgery is most effective in locales where there are few surgeons and/or other specialists. Currently, it is being tested in foreign countries, including Saudi Arabia, where doctors from Europe and the United States work with local physicians to save patients. Robotic surgery will also be used in delicate, time-consuming surgeries where the smallest mistake could cost the patient's life, such as brain and heart operations.

Unlike other types of medical technology, robotic surgery will have to prove without a shadow of a doubt that it will work before becoming accepted by the mainstream medical establishment. The benefits far outweigh the risks, however, and the technology will probably come into its own within the next 20 years.

On-line Medical Databases/Forums

Practicing doctors often need to learn new techniques or find out about new medications. Until recently, they frequently had to wait for medical bulletins or attend conferences to find out new ways to treat patients. Now, most physicians can connect to on-line medical databases that can be searched using a keyword. These databases describe new procedures and medications, possible side-effects, and where to find more information.

Likewise, in the past, most patients had to rely on doctors to inform them about their condition. They had virtually no way to speak with others who shared their plight and discuss what treatments worked, which didn't, and what potential problems could occur. Patients in isolated or rural areas suffered the most, since there were few libraries or support groups available.

But now, users of on-line services and the Internet can speak to others on-line with the same medical conditions. These groups become a support system that helps patients better survive their illnesses. More than a way to exchange information, they often become a circle of friends sharing one another's pain and offering each other solace and hope. This non-traditional type of medical support allows the patient to take more control over an illness.

Doctors are beginning to realize that patients with a positive outlook live longer and fuller lives. So on-line support groups have been gaining the attention of medical professionals. Many doctors and nurses treating certain ailments sign on to give support and suggest alternative therapies. The American Medical Association (AMA) and other groups have also set up databases where users can download information about their condition. This type of technology will continue to grow as more and more people learn to navigate the information superhighway.

Neural Networks

Neural networks are advanced computer networks that are capable of learning from past experiences and using that information to solve a current problem. Neural networks are being used to find breast cancer and brain tumors in patients, for example. They are very effective at discovering disease in its early stages, which human doctors and radiologists might miss.

Although neural networks have been around since the early 1950's, they are still in the initial phases of development. But with the medical success neural networks have had, programmers will continue to make modifications and improvements in them that will aid in the development of other life-saving techniques.

u contributed by the JDC Editorial Staff

World Wide Web (WWW or Web)

A menu-based search tool that enables users to access Internet resources worldwide by using links embedded in documents. These linked documents allow users to move easily from place to place within the Internet in a non-linear fashion.

The World Wide Web (also known as WWW or Web) is the most recent and fastest-growing addition to the family of tools used to access information on the Internet. It uses embedded document codes to link information stored on computers around the world, which can then be viewed by using a graphical user interface (GUI) known as a Web browser  .

The WWW is based on embedded codes, known as hyperlinks, which are written directly into documents using a programming language called HyperText Markup Language (HTML). These links, while not seen directly by the user, provide references to other documents, to additional information within the same document or to other Internet resources, servers or search tools. Some of these links also contain Uniform Resource Locator (URL) addresses, a text string that indicates the actual location of a linked file or resource. Web browsers, which recognize the imbedded links, are then used to navigate between the various documents and resources. For example, someone looking for information on art of the Renaissance might conduct a keyword search using one of the many search engines available on the Web. The search engine will find any location on the Web containing information related to art and the Renaissance, and transfer these documents back to the Web browser for viewing. These locations may include information uploaded by individuals, research institutions, museums and corporations. The information may contain text, graphics, audio and video.

Several Web browsers are commonly available for WWW use. The best known is Mosaic, a freely available, versatile graphical interface that can provide access to almost every area of the Internet. Written by the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign, Mosaic is a multi-platform browser, which means that can be used on a variety of computer systems. Like several other browsers, Mosaic can display both text-based and multimedia documents that can include images, sounds, movies and other media from a variety of sources. It also allows users to create their own home pages, the WWW documents used to provide the first link to the Web.

A typical WWW session starts at a home page, which can be chosen by the user or by a site administrator. This page, which often becomes the user's favorite starting point for browsing the Web, usually contains information about the home page's sponsoring individual, group, or agency, as well as announcements of new services and developments in various areas of the home page. Graphical browsers like Mosaic highlight linked information by using colors or underlining; users then click on the highlighted text to travel to the linked sites. The browser software makes the connection to each link in the background of the Web session, allowing the user to continue reading the current document while the browser searches the Web for the next document requested.

Users move from link to link by clicking on highlighted text within each document. Once a specific information search is completed, they can then return to an earlier page or resource, begin a new search or end the Web session.

The idea of an on-line network that would provide access to the broad resources available through the Internet was first advanced in the late 1980’s as a way to exchange research and information in the field of high-energy physics. Several Web prototype projects were conducted; however, the Web as it is known today is the product of the World Wide Web hypermedia project, which was developed in the early 1990’s at the European Laboratory for Particle Physics (CERN) in Switzerland.

u contributed by Sonia Weiss

Tesla, Nikola (1856 – 1943)

Yugoslavian-born American electrical engineer and inventor, recognized as one of the pioneers in the development of electrical power.

Nikola Tesla was born to Serbian parents on July 10, 1856, in Smiljan, Croatia. He was reportedly born during an electrical storm — perhaps a sign of the unwavering direction of his life's work. When Tesla left his childhood home to pursue studies at the Polytechnic School in Graz, Austria, he had intended to study physics and mathematics, but instead became interested in electricity. Later, he continued his studies at the University of Prague.

Tesla was first employed with the Austrian government's telegraph engineering department. In 1881, he discovered the principle of rotating magnetic fields that would eventually become the basis for virtually all alternating-current (AC) machinery. Tesla moved to Paris in 1882 to accept an engineering position, and built his first induction motor a year later. By this time, his experiments had convinced him that worldwide wireless electrical systems were possible. In 1884, Tesla immigrated to the United States, where others were investigating the mysteries of electricity. He became a naturalized U.S. citizen in 1889.

For a time after coming to the United States, Tesla was employed by inventor Thomas A. Edison; however, the two constantly quarreled and Tesla soon left to establish his own laboratory in New York City. In 1888, he developed a practical system for generating and transmitting alternating current. American inventor George Westinghouse purchased the rights to this groundbreaking invention and, in 1893, he demonstrated Tesla's device by lighting the World's Columbian Exposition in Chicago. Two years later, Tesla's alternating-current motors were installed at the Niagara Falls power project.

By the late 1890's, Tesla had begun to feel that his experiments (which could generate up to four million volts of electrical current) were too dangerous to conduct in New York City. He contacted Leonard Curtis, a major investor in Colorado's growing power industry, and explained his need for space and secrecy to conduct experiments. Curtis responded by arranging free power and lodging. Tesla, with financing from John Jacob Astor and other wealthy investors impressed with his work in New York City, reached Colorado Springs, Colorado, on May 17, 1899. On his arrival, he regaled the local press with his plans to study lightning and conduct wireless experiments. Outside Colorado Springs, work began immediately on Tesla's laboratory — a towering structure topped by a 200-foot mast and a one-meter copper sphere. The fenced complex was posted with large signs warning "KEEP OUT — GREAT DANGER." By mid-summer of 1899, Tesla's laboratory was ready. Each day, in spite of his fear of horses, Tesla traveled by rented buggy to the lab.

Tesla's pioneering work focused on proving that the Earth possesses an electrical charge and experimenting with ways to alter its magnitude. In a 1905 article reflecting on his research, Tesla said, "The Earth was found to be, literally, alive with electrical vibrations, and soon I was deeply absorbed in this interesting investigation." Coils in Tesla's lab vibrated with the Earth’s energy surges and created the potential of more than 100 million volts. In one experiment, enormous electrical impulses radiating from the laboratory were rumored to have brought replies from other galaxies. On the night Tesla pushed his machinery to its maximum capacity, he was in his finest evening clothes. Bolts of lightning flashed over 130 feet in the air — thunder created by the experiment was heard miles away. And then, suddenly, the night was still and quiet. Tesla telephoned the Colorado Springs power company to ask that they restore his power, but their generators were ruined and the entire town was in darkness. Tesla would receive no more free power from Colorado Springs, and Astor refused additional funding. On January 13, 1900, Tesla, heavily in debt, left Colorado Springs. Several years later, his lab was demolished to satisfy creditors.

Tesla’s research had convinced him that wireless communication and power transmission were possible utilizing the natural forces of the Earth. He envisioned a series of transmission plants around the globe. The first of the plants, to be built on Long Island, New York, was financed by New York industrialist J. P. Morgan and called the Wardenclyffe Transatlantic Broadcasting System. Unfortunately, Tesla had underestimated the costs and was unable to secure additional funding to complete construction and prove his theories. The plant was never finished. Later, during World War I, it was torn down for fear that European-born Tesla might use it to send messages to America’s enemies.

Nikola Tesla’s inventions included high-frequency generators, the Tesla coil (a transformer crucial to radio communications), oil-insulated capacitors, new types of dynamos, induction coils, condensers and incandescent lamps. He is said to have predicted the laser beam, the transmission of pictures to a receiving set (later called a television) and guided missile defense systems.

In 1912, Tesla was selected to receive the Nobel Prize in Physics with the stipulation that he share the prestigious award with Thomas A. Edison. Tesla, recalling his old animosity toward Edison, refused to share the $40,000 prize. Consequently, he received nothing.

Nikola Tesla, eccentric genius, lived his last years quietly in the New Yorker Hotel. In 1936, his 80th birthday was commemorated with scientific gatherings held throughout Europe. During his last seven years, he survived on a pension from the Yugoslavian government. Nikola Tesla was 86 when he died in New York City on January 7, 1943.

u contributed by Susan P. Sanders

Hewlett, William Redington (1913 –   )

American engineer and business executive who, with partner David Packard, founded Hewlett-Packard (HP), international manufacturer of products used in industry, engineering, science and medicine; currently Director Emeritus of Hewlett-Packard.

William R. Bill Hewlett was born on May 20, 1913, in Ann Arbor, Michigan. In 1934, he received his bachelor of arts degree from Stanford University in California. While at Stanford, Hewlett had become acquainted with another undergraduate student, Dave Packard. After graduation, the two left for the Colorado mountains for two weeks of camping and fishing. During that trip, the men cemented a friendship that would span a lifetime.

Hewlett earned his master's degree in electrical engineering from Massachusetts Institute of Technology (MIT) in 1936. He then returned to California and began doing freelance electromedical research at Stanford. He also continued to pursue his studies and received the degree of Engineer from Stanford in 1939.

While Hewlett and Packard were students at Stanford, one of their professors and mentors was Frederick Terman. Terman — considered by many to be the founder of Silicon Valley — had arranged a student tour of television pioneer Philo T. Farnsworth's lab in San Francisco. The two young men were inspired and talked of starting such a venture themselves someday. They could not have foreseen the tremendous success that lay ahead.

In 1939, with encouragement from Terman, Bill Hewlett and Dave Packard decided to begin their business partnership. They scraped together $538, rented a small garage in Palo Alto and tossed a coin to decide its name. Hewlett-Packard (HP) came up the winner. The company had only one product — a resistance-capacitance audio oscillator that Hewlett had designed while he was in graduate school. The device they called the 200A audio oscillator (the model number 200 was chosen so customers wouldn't think they were buying from novices) was superior to its competitors for measuring the frequency of sound. And, it was priced reasonably at $54.40. The Hewlett-Packard Company was launched.

One of the company's first customers was Walt Disney, who purchased eight oscillators to use in making the animated motion picture *Fantasia*, which was released in 1940. Business grew steadily after that. Hewlett and Packard ran the fledgling company together until Hewlett left to serve in the U.S. Army during World War II. During his first tour of duty, he was on the staff of the Army's Chief Signal Officer. Later, he headed an electronics unit at the War Department and was part of a U.S. team charged with inspecting Japanese industry following the end of the war. Years later, Hewlett directed HP when Packard served as U.S. Deputy Secretary of Defense from 1969 to 1971.

In 1947, after Hewlett returned to HP from his wartime service, he became a vice president of the firm. Ten years later, he was elected Executive Vice President. In 1964, Hewlett became President of Hewlett-Packard, and he was named Chief Executive Officer in 1969. Hewlett retired as HP's President in 1977 and as CEO a year later. He served as Chairman of the Executive Committee until 1983. At that time, he was named

Vice Chairman of HP's Board of Directors. In 1987, Hewlett was named Director Emeritus of Hewlett-Packard. Today, HP is an international company that manufactures and services electronic products and systems for measurement, computing and communication used in business, industry, engineering, science, medicine and education. Still headquartered in Palo Alto — and with facilities in 120 countries around the globe — HP is a $30 billion business with 99,900 employees.

Hewlett, who has been described as a technical genius, has been a major force within the electronics industry. He has served on the board, including a stint as President, of the Institute of Electrical and Electronics Engineers (IEEE), and he played a crucial role in the development of the American Electronics Association. In 1985, then-President Ronald Reagan awarded Hewlett the nation's highest science honor, the National Medal of Science.

Over the course of his career, Hewlett has been awarded 13 honorary degrees from such distinguished institutions as Yale University, the University of California at Berkeley, the University of Notre Dame, Dartmouth College and the University of Bologna in Italy.

His résumé also lists over two dozen prestigious awards in addition to the National Medal of Science. Among these are MIT's Corporate Leadership Award, the Silicon Valley Engineering Hall of Fame Award, the National Inventors Hall of Fame Award and the Boy Scouts of America's Distinguished Citizen Award.

In addition to engineering and science, Hewlett also has maintained interests in education and medicine. He has served as a trustee of both Mills College in Oakland, California, and Stanford University. He also has been active on the boards of the Palo Alto-Stanford Hospital Center (now Stanford Medical Center), the Drug Abuse Council in Washington, D.C., and the Kaiser Foundation Hospital and Health Plan. He is an honorary trustee of the California Academy of Sciences, a member of the National Academy of Engineering and the National Academy of Sciences, and a fellow of the American Academy of Arts and Sciences. He has served as Chairman of the William and Flora Hewlett Foundation from 1966 to 1995, and he is Trustee Emeritus of the Carnegie Institution in Washington, D.C.

In addition to his numerous other activities, Hewlett has sustained a broad range of hobbies, many of them connected to his love of the outdoors. He is a skier, amateur botanist, fisherman and mountain climber. With Packard, he owns ranching and cattle-raising businesses in California and Idaho.

In 1982, Hewlett was invited to give an address at the University of Notre Dame. The topic he chose was The Human Side of Management. During that speech, Hewlett spoke of the early days at HP. He shared the tragic experience of a company employee who was stricken with tuberculosis and how that event led he and Packard to establish a medical insurance plan (very unusual in the early 1940's) for their employees. In part, he said, as I talk about the start of the company, it is important to remember that both Dave and I were products of the Great Depression. We had observed its effects on all sides, and it could not help but influence our decision on how a company should be run. Two thoughts were clear from the start. First, we did not want to run a hire-and-fire operation, but rather a company built on a loyal and dedicated work force. Further, we felt that this work force should be able to share to some extent in the progress of the company. Second, we wished to operate, as much as possible, on a pay-as-you-go basis, that our growth be financed by our earnings and not by debt.

Those solid values have been the foundation for the huge success enjoyed by Hewlett-Packard for over five decades. And they are the same values that have made Bill Hewlett — engineer, entrepreneur, humanitarian — one of the great Americans of the twentieth century.

u contributed by Susan P. Sanders

Armstrong, Edwin Howard (1890 – 1954)

American electrical engineer, college professor and inventor who is best known for developing the frequency modulation (FM) system for radio broadcasting.

On December 18, 1890, Edwin Howard Armstrong was born in New York City. His mother was a former teacher and his father a publisher. By his early teens, the shy boy had heard of the first wireless messages being transmitted across the Atlantic Ocean. At that time, wireless technology was in its infancy and only able to transmit faint signals. Intrigued, Armstrong began to conduct wireless experiments in the attic of his family's home.

After graduating from high school in Yonkers, New York, Armstrong enrolled at Columbia University's School of Engineering. Each day, he traveled to class on a red motorcycle that his parents had given him. And, he continued his experiments.

In the fall of 1912, during his third year at Columbia, an invention Armstrong had developed suddenly began to receive signals that could be heard across the room. The device — a regenerative, or feedback, circuit — had evolved from his painstaking experiments with a vacuum tube which had been invented in 1906 by Lee de Forest, a pioneer in wireless telegraphy. In addition, at its maximum amplification, the tube's circuit was transformed from a amplifier to an oscillator (or generator) of wireless waves. This radiowave generator remains a fundamental component of virtually all modern radio and television broadcasting systems.

De Forest challenged the originality of Armstrong's invention. The case evolved into an agonizing series of patent lawsuits that continued for over 14 years. Finally, after being argued twice before the U.S. Supreme Court, a ruling was made in favor of de Forest's claims. The controversial verdict, however, was never fully accepted by many of the two inventors' peers. The Institute of Radio Engineers stood by the gold medal it had previously awarded to Armstrong. After the court's decision, Armstrong was also recognized with the Franklin Medal — one of America's highest scientific honors — for the invention.

After graduating from Columbia in 1913, Armstrong accepted a teaching position at the university. In 1917, at the outbreak of World War I, he joined the U.S. Army Signal Corps. He became a Captain and was stationed in Paris. At that time, Allied receivers were unable to intercept high frequency transmissions beamed from German field radios. To overcome this severe disadvantage, Armstrong set to work in the laboratory. The result was his invention of the superheterodyne circuit, which is able to receive, amplify and convert weak, high-frequency electromagnetic waves.

After leaving France in 1919, Armstrong returned to Columbia University. He became assistant to Columbia professor Michael Pupin, a respected physicist, and secured a patent for his wartime invention. Two years later, he was granted a patent for the super-regenerative receiver. Armstrong shrewdly sold the rights to these groundbreaking inventions to several major corporations, including the Radio Corporation of America

(RCA). At the age of 32, Armstrong was a millionaire.

While continuing to teach at Columbia (he succeeded his mentor Pupin as Director of Electrical Research in 1935), Armstrong pursued his experiments, financing them with his own money. His passion was to resolve the long-standing problem of radio static. In 1933, Armstrong was granted four patents for advanced circuits that would revolutionize broadcasting. He had developed a radically new radio system — called frequency modulation (FM) — that was impervious to static.

Before receiving his FM patents, Armstrong had demonstrated his new radio system for RCA executives. In 1934, FM equipment was installed on the Empire State Building tower for RCA to test. But the company did not make a decision to buy Armstrong's design. Eventually, Armstrong decided RCA was secretly trying to develop its own version of his invention. Consequently, in 1939, Armstrong used his personal money to build the world's first FM station in Alpine, New Jersey. Later, RCA began producing FM transmitters and receivers. The company, however, refused to pay any royalties to Armstrong. He responded by filing patent infringement lawsuits.

While Armstrong's legal struggles dragged on, FM slowly gained acceptance. RCA offered settlements, but they were unacceptable to Armstrong. He stubbornly pursued the lawsuits, and his fortune was exhausted by these relentless battles. Finally, on February 1, 1954, a discouraged Armstrong reportedly donned his overcoat and hat and flung himself from a thirteenth floor window in New York City.

Following his death, Armstrong increasingly has been recognized as a genius and invaluable contributor to the field of electronic communications. He was posthumously inducted into the prestigious Union International des Telecommunications, joining such luminaries as telephone inventor Alexander Graham Bell and wireless telegraphy pioneer Guglielmo Marconi. And his vision for FM has been vindicated — today it dominates radio, is mandated for television sound transmission and is fundamental to advanced technologies including satellite communications.

u contributed by Susan P. Sanders

Negroponte, Nicholas (1943 –   )

American educator, lecturer and visionary who is founder and Director of the Massachusetts Institute of Technology (MIT) Media Laboratory.

Nicholas Negroponte was born December 1, 1943, in New York City. He is one of four sons (his brother, John, is U.S. ambassador to the Philippines) in an affluent shipping family. His father was an organizer and member of the 1936 Greek Olympic ski team. During his youth, Negroponte lived in Switzerland, London and New York. After attending private schools, he enrolled in Massachusetts Institute of Technology (MIT) in 1961 to study architecture. He received his bachelor's degree in 1965 and his master's degree a year later — both in architecture — and joined MIT's faculty in 1966.

For several years after joining MIT's teaching staff, Negroponte also held visiting professorships at the University of Michigan, Yale University and the University of California at Berkeley. In 1967, he launched MIT's Architecture Machine Group, an innovative laboratory where revolutionary ideas concerning the interaction between humans and computers were explored. He used his experiences there to author several books, including *The Architecture Machine* and *Computer Aids to Design and Architecture.*

In 1980, Negroponte was founding Chairman of the Computers in Everyday Life program sponsored by the International Federation of Information Processing Societies in Amsterdam. Two years later, he accepted an invitation from the French government to become the first Executive Director of the Paris-based World Center for Personal Computation and Human Development — an innovative project dedicated to studying the use of advanced computer technology in underdeveloped countries.

In 1985, with support from MIT's then-President Jerome Wiesner, Negroponte founded the MIT Media Laboratory (Media Lab). With Negroponte as its visionary Director, the Lab is a unique research center focused on exploring futuristic ways for humans to interact with information. Today, the Lab is supported by millions of dollars contributed by over 100 corporations from around the globe, as well as endowment funding and federal contracts. The Lab is considered a distinctive national reflection of America's wealth of technological and intellectual resources. Among the Lab's 101 current research projects are Television of Tomorrow, School of the Future, News in the Future, Things That Think, Information and Entertainment Systems and Holography. The Lab offers both graduate and undergraduate courses in media arts and sciences. In addition, it offers MA and Ph.D. degrees in media arts and sciences.

In a 1992 interview published in *Technology Review*, Negroponte succinctly summarized his vision when he was asked what he considered the biggest challenge facing the Media Lab: "Making computers with common sense and understanding. And to do that, we need to understand understanding itself. Today, computers push bits and pixels around with no knowledge of what they are. But as soon as signals have a sense of themselves, and communication channels can recognize content, we can begin to build truly personalized systems that filter and fashion information for an audience of one."

In addition to guiding the Media Lab, Negroponte is a tenured professor of media arts and sciences at MIT. Considered a prophet of the personal computer revolution, he is a valued advisor to government, media and industry leaders. Negroponte is an investor and senior columnist for *Wired*, a magazine for on-line enthusiasts, and recently authored a book entitled *Being Digital*. He travels over 300,000 miles each year — giving speeches, raising money for the Media Lab, and consulting with the rich, the famous and the influential. On one recent trip, he visited with old friend Arthur C. Clarke, author of *2001: A Space Odyssey*, who lives in Sri Lanka. Negroponte disdains the telephone but is on-line for hours daily communicating from wherever his travels take him.

In 1990, Negroponte delivered the Murata "People Talk" address in Japan, an event so prestigious that a national competition was held for tickets. He hosted a 1994 MIT symposium on computers and the arts that attracted such luminaries as rock musician Peter Gabriel, composer Quincy Jones, movie special effects legend Douglas Trumbull and video game pioneer Nolan Bushnell.

When not globetrotting, Negroponte (along with his wife, Elaine, and a bulldog named Clara Bow) alternately lives in a townhouse on Boston's Beacon Hill, a home on the Greek island of Patmos or a family residence in Klosters, Switzerland. He also maintains a home in France where he indulges his love of cooking.

In a March 1, 1995, interview with the *Boston Globe*, Negroponte discussed his philosophy. "Computing is not about computers," he said, "it's about life. We're discussing a fundamental cultural change. Being digital is not just being a geek or Internet surfer or mathematically savvy child, it's actually a way of living and is going to impact everything. The way you work, the way you study, the way you amuse yourself, the way you communicate with friends."

u contributed by Susan P. Sanders

Weaver, Sylvester Laflin "Pat", Jr. (1908 –   )

American television network executive and programming strategist, advertising agency executive and pay television company president. One of television's most innovative individuals, "Pat" Weaver has left a lasting legacy in television programming through his concepts of the "talk show" and the television "special." In addition to serving as President of the National Broadcasting Company (NBC), he also worked with such well-known national advertising agencies as Young & Rubicam, McCann-Erickson and Wells, Rich, Greene.

Sylvester L. Weaver, Jr., known professionally as "Pat" Weaver, was born December 21, 1908 in Los Angeles. He began his career in the late 1920's working in broadcasting and advertising. His experience included a brief period at the Columbia Broadcasting System (CBS) as a writer-producer as well as working with the Don Lee radio network. In 1930, he earned an AB degree from Dartmouth, where he graduated magna cum laude. He married Elizabeth Inglis on January 23, 1942. From 1943 to 1944, he was the commanding officer of U.S.S. PC 492. During the late 1940's, he moved into advertising, and was named advertising manager for American Tobacco. From there, he moved into the position of Vice President of Radio-Television at Young & Rubicam Advertising.

In 1949, he started at NBC as Head of Television Operations. His notion that television viewers who saw the same programming week in and week out would become too bored was a radical concept, indeed, especially from the network advertisers' points-of-view. Nonetheless, he persisted in his belief that a television "spectacular" interspersed at varying intervals would be a nice change for NBC viewers. Thus, he created the concept of the television "special," which has been enduring television fare for the past 40 years.

On December 4, 1953, he was appointed President of NBC. Although he served in that capacity for a very short time, until December 7, 1955, he made a lasting impact on programs that American viewers still see today. During his brief tenure at NBC, he created the concept of the "talk show," in addition to the very popular television "special." In 1952, the *Today* show premiered on NBC with host Dave Garroway, best known for his easy-going style of presentation.

Also during Mr. Weaver's leadership, in 1954, *The Tonight Show* began its legendary run on NBC. The first host of the program was Steve Allen. His celebrity successors include Jack Paar, Johnny Carson and Jay Leno, the program's current host.

Pat Weaver also created the concept of the *Wide Wide World* television show. In radio programming, he developed the program, *Monitor*, which ran each weekend on NBC Radio for an extended period of time.

Because of a disagreement with NBC's parent company, Radio Corporation of America (RCA), Weaver left the organization in 1955 after having been named Chairman. Former RCA head David Sarnoff's son, Robert, then became the president of NBC, and remained in that position until 1975. Following his departure from NBC, Weaver considered starting his own broadcast company. Soon after, he returned to the advertising arena, where he joined McCann-Erickson’s management team.

In 1963, he joined Subscription Television, Inc. (STV) in California as President. This company was well-funded, with more than $25 million in operating capital coming from major corporations and well-known sports and entertainment organizations including the San Francisco Giants and the Los Angeles Dodgers. Weaver led the company’s efforts to launch one of the first paid-television companies in the country. Boasting alternative programming with new films, cultural features and broadcasts of sporting events, the company’s goal was to provide this paid service to Los Angeles and eventually San Francisco.

More than 4,000 subscribers in the Santa Monica area of Los Angeles participated in STV when it premiered during the summer of 1964. Soon after, it extended its operations to San Francisco. However, perceiving STV to be a major threat, movie theater owners in the area joined forces to fight the new service. They were successful in initiating a referendum that appeared on the November ballot. Area voters defeated the referendum by a large margin. The company, in turn, filed suit for the right to conduct business. By the time the court ruled in favor of STV, however, it had run out of funds. Shortly thereafter, Weaver returned to the advertising agency scene, joining Wells, Rich, Greene as a consultant.

Considered one of the most talented people ever to head a network, Pat Weaver is the recipient of countless awards. He received the George Foster Peabody Broadcasting Award in 1956, and an Emmy Award in 1967. He is also the recipient of the Sylvania, Look and Variety Awards. In 1985, he was named to the Television Hall of Fame. He also is a member of Phi Beta Kappa.

Now retired and living in Santa Barbara, California, Pat Weaver is the father of two grown children. They are Trajan Victor Charles and Susan Alexandra, who has achieved great success as an actress. Her stage name is Sigourney Weaver.

u contributed by Valerie Switzer

Atanasoff, John Vincent (1903 –)

American physicist and inventor, credited with inventing the first nonprogrammable electronic computer — the ABC (Atanasoff-Berry Computer) — with the help of a graduate student, Clifford Berry.

Atanasoff was born in Hamilton, New York, in 1903. He received a BS from the University of Florida, a master's degree from Iowa State College, and received his doctorate in physics from the University of Wisconsin in 1930.

Sponsored by the Iowa State Research Council and aided by part-time graduate student Clifford Berry, Atanasoff devised an electronic computer called the ABC in 1940. Using a modest 800 vacuum tubes, the ABC was the first electronic computer, but it was not programmable and contained no stored programs that could be changed or accessed.

In 1968 Honeywell legally challenged Sperry, holder of the patents by John Presper Eckert and John W. Mauchly for the ENIAC computer. Honeywell brought in Atanasoff because of his similar work (with which Mauchly was familiar) preceding the ENIAC's completion. The judge ruled in Honeywell's favor and identified Atanasoff as the inventor of the electronic computer. One major difference between the machines, however, was that the ENIAC was programmable and the ABC was not; thus the ENIAC's operating program could be changed by the operator while the ABC's could not.

Despite the judge's ruling, Eckert and Mauchly are still credited with building the ENIAC, the first electronic programmable computer. And John V. Atanasoff is still considered a computer pioneer, whose work greatly influenced others.

u contributed by Kay S. Volkema

Hawkins, William M. “Trip” III (1953 –   )

American businessman and entrepreneur, currently the Chief Executive Officer (CEO) and President of The 3DO Company, a pioneer in interactive consumer electronic games; 3DO is based in Redwood City, California.

William Hawkins, or “Trip,” as he is most often called, started his entrepreneurship at a rather young age. When he was in high school, he borrowed $5,000 from his father to start his first business, a fantasy football game. It failed, but the lessons he learned have been put to good use in his subsequent ventures.

The idea of games as a science and business must have been overwhelmingly intriguing for Hawkins. While a student at Harvard University, he earned a degree in strategy and applied game theory. Degrees in this particular science were not available at Harvard until Hawkins arrived and convinced the administration to offer them. He developed a computer simulation of World War III as his senior thesis. After Harvard, Hawkins went on to receive an MBA from Stanford University and almost immediately was hired by Steven Jobs to work at the then-new Apple Computer company.

Hawkins was instrumental in introducing Apple to the business market. After four years of Apple experience, Hawkins gathered up some of his stock and started his own company, Electronic Arts Inc. Electronic Arts has become one of the larger suppliers of software for electronic game devices. When he launched the company in 1982, the field of competitors was entirely too crowded. To not only survive, but also to rise to the top, is an achievement of which Hawkins is proud. His unique vision and sense of timing were ideal for the industry.

At its inception, Electronic Arts produced games for personal computers and then cartridges that were played on hardware produced by video game manufacturers such as Sega and Nintendo. These manufacturers charge software companies a royalty per cartridge for the right to produce and sell a game for the game machines. Depending on the specific agreement, most royalties were anywhere from $7 to $12 per game, but could be as high as $20.

While successfully running Electronic Arts, Hawkins grew increasingly frustrated with certain aspects of the business. High royalties, limitations of the game hardware and increased capabilities of CD-ROMs in terms of richer multimedia applications (video, audio and text) were all part of Hawkins’ reasons to start 3DO. Still company Chairman even after leaving Electronic Arts, Hawkins started 3DO in 1991.

Almost immediately, companies such as Matsushita Electric Industrial Company, Ltd.; Time-Warner, Inc.; AT&T; and Electronic Arts invested in 3DO, giving the young company a huge boost in credibility and it seemed that, again, Hawkins had hit the jackpot.

3DO’s initial plan was to not produce hardware or software, but to license these items to manufacturers. What 3DO planned to concentrate on instead, and what Hawkins is particularly skilled at, is coming up with the ideas. And the company's initial big idea was to utilize the better, faster CD-ROM technology with 32-bit systems for its game base. Although CD-ROM technology lacked the high-speed quality of 16-bit video games, it offered superior graphics and sound capabilities instead. The ability to interact with the game characters (while being newer and "cooler") was a natural consumer draw. Hawkins, in effect, built a new industry based on this new technology.

To ensure success and entice hardware manufacturers to CD-ROM technology, Hawkins gave them the designs and specifications for the game machines for free. He also provided technological help to the software developers, who were charged only a $3 royalty per game disc sold. When the game machine prototypes were unveiled in January 1993, excitement and anticipation were high. Ten months later, when Matsushita introduced the Panasonic REAL 3DO Interactive Multiplayer, however, sales were agonizingly slow. The high price tag of $699 was quickly dropped to $499 and then $399, but even that was still a lot more than a Sega or Nintendo machine, which usually top out at under $200.

An expensive machine was a stumbling block, but what was equally prohibitive to Hawkins and his company was the lack of a great game. 3DO's situation was almost a "chicken and egg" issue — the company couldn't sell enough machines until there were some great game titles available, and there wouldn't be enough great game titles until there were enough machines in consumer hands. As quickly at the game machine prices came down, 3DO suppliers scaled back planned products, signaling doom for the company. Hawkins, who was highly regarded as a creative genius as well as a smooth marketer, had to dig a little deeper to ensure success.

The industry term for the number of machines sold is *installed base*. Hawkins focused on reaching an installed base of 100,000 and 100 software titles by Christmas of 1994.

But Hawkins didn't really have control over the situation. Since his company didn't actually make the machines to play the games, he couldn't specify a price tag. (His competitors often sold machines at a loss to build and dominate the market.) Likewise, he didn't have direct control over the number of games on the market. In a move that angered some software manufacturers, Hawkins announced an additional $3 per game charge to go into a market development fund. Part of this was to go to advertising costs and part to the hardware manufacturers. His move came at a time when the software manufacturers had already made commitments to retailers for the Christmas season, so the additional money would come directly from their profits. While the amount was lowered to just $1 per game, it showed Hawkins was searching for ways to ensure the success of his company.

Fortunately, with dogged determination, continually striving for bigger and better, stock offerings, creative incentives, some more of his own money and a little luck, Hawkins has been able to overcome any reluctance the hardware and software manufacturers have had, and 3DO has become a reigning leader in the industry.

Christmas 1994 was a success for Hawkins — 3DO products represented 35 percent of the category sales at the retail level. He reached his goal of 100 titles, four game manufacturers and prominence in 15 countries on three continents. 3DO became the definitive world-wide leader for the industry. Two games, *Road Rash* and *FIFA*

International Soccer, were heralded for their sense of excitement and fun and were rewarded with numerous industry awards. To further push game titles, 3DO started its own software development studio to compete with outside game developers.

In May 1995, when 3DO's world-wide installed base reached 600,000 units, 200 game titles were available and the industry acknowledged 3DO with award after award, the company forced a giant leap in the industry. Hawkins unveiled plans for a new 64-bit architecture called the M2. This newest technology is based on the Power PC microprocessing chip and surpasses the existing 32-bit technology with seven to 10 times more power and with the quality and performance of workstations and arcade games. With the capability to reproduce highly detailed images, interactivity and incredible sound, this technology far surpasses anything currently on the market, according to Hawkins. And unlike that of 3DO's competitors, the M2 technology can be utilized by the older machines with the purchase of a simple add-on upgrade. In effect, older machines don't become obsolete with the new technology, something that has often happened with Sega and Nintendo machine advances. Manufacturer and consumer reaction to the newer, faster and definitely "cooler" M2 technology remains to be seen. Sony's Playstation, Sega's Saturn and Nintendo's Ultra 64 are all competing with 3DO's M2 as the next generation game machine.

Trip Hawkins has a vision of home entertainment. While striving for a leading position in the industry, he clearly wants to make sure the formulas and recipes are shared. If technology isn't standardized, the focus becomes competition with other manufacturers rather than creating products for the consumer. Hawkins can point to historical data — the Beta system losing ground to the now near-universal VHS video technology, for example — to illustrate the situation he wants his company to avoid. Today Hawkins' company develops, publishes, licenses and distributes CD-ROM hardware, software and accessories for the 3DO system.

u contributed by Michele Messenger

Editor's Notes:
In October 1995 3DO signed an exclusive license with Matsushita Electrical Industrial Co., Ltd. for its 64-bit M2 technology. The deal is reportedly worth over $100 million to 3DO.

Roberts, Ralph J. (1920 –   )

American cable television executive, entrepreneur, community leader and board member; founder and current Chairman of Comcast Corporation, one of the ten largest cable television companies in the United States. Ralph Roberts is best known for his strong leadership qualities that have made Comcast Corporation one of the leading telecommunications companies in America today, and for his support of Joseph Segel, founder of QVC Inc.

Born on March 13, 1920, Ralph J. Roberts is a 1941 graduate of the University of Pennsylvania Wharton School. He earned a BS in Economics and was a participant in the War Production Board Training Program prior to serving as a Lieutenant in the U.S. Navy from 1942 to 1945. From 1946 to 1948, he was an Account Executive with Aitken Kynett Advertising, an agency in Philadelphia.

That same year, he moved to Muzak Corporation in New York City, where he served as Vice President until 1950 and was responsible for advertising, public relations, marketing and sales promotion. During his tenure at Muzak, he also worked directly with Senator William Benton on business matters concerning the *Encyclopedia Britannica.*

In 1950, he joined the Pioneer Suspender Company in Philadelphia as Executive Vice President and Director of Advertising. From 1956 to 1961, he was President and Chief Executive Officer of the company, which was later known as Pioneer Industries, Inc. It was a manufacturer of men's accessories and its principal products were leather goods and jewelry.

In 1961, Roberts realized that his current business had peaked out and that it was time to move on. He sold Pioneer Industries, Inc. to Hickok Manufacturing Company, and started International Equity Corporation (IEC), an investment and venture capital company.

In 1963, Roberts was approached with an intriguing offer. Daniel Aaron, a former executive for Jerrold Electronics, had secured a contract to sell a small cable system in Tupelo, Mississippi. Aaron contacted Roberts, who agreed to purchase the cable system if Aaron would join him in running the business. Aaron agreed. Julian Brodsky, Roberts's accountant at the time, indicated that he wanted to be part of the team. It was the beginning of an amazing American success story.

During the next few years, Roberts, Aaron and Brodsky led Comcast Corporation through a number of additional cable system acquisitions. Roberts's son, Brian, joined Comcast in 1981. And in 1985, the company submitted a proposal to buy Storer Communications, Inc. While the offer was not accepted at the time, it positioned Comcast as a major player in the cable television industry.

Shortly thereafter, the company was invited to participate with a group of investors joining to buy the Group W Cable systems. Then, in 1988, Comcast joined with Tele-Communications, Inc. (TCI) in offering $1.5 billion to buy Storer Communications. This time, the offer was accepted, and Comcast and TCI were successful in their efforts to buy the company. Two years later, in 1990, Brian Roberts was named President of Comcast at the age of 30.

It is interesting to note that Ralph Roberts was a major source of support for Joseph Segel, founder of QVC Inc. Impressed by Segel's successful Franklin Mint, a mail-order company specializing in upscale collectibles, Roberts encouraged Segel to start QVC Inc., the highly successful home shopping channel. Comcast invested a sizable sum of cash in the endeavor, and Ralph Roberts called many of his contacts within the cable television industry to encourage them to make QVC part of their cable system programming.

In 1992, when Segel chose to leave QVC, Ralph supported Brian who led an all-out effort to secure Barry Diller, former Fox Network Chairman, to be the new Chairman of QVC. In fact, Barry Diller was named Chairman at that time and invested more than $25 million of his own money in the venture. In the change of leadership, Comcast Corporation acquired 15% ownership of QVC.

However, Ralph and Brian Roberts were not content with the smaller ownership package the company acquired in 1992. In an aggressive move, Comcast submitted an offer in 1994 to purchase controlling interest in QVC. This was in partnership with Liberty Media, a wholly owned subsidiary of Tele-Communications, Inc. (TCI). The offer was accepted, and Comcast now owns a 57 percent controlling interest of QVC while Liberty Media owns 43 percent. This takeover thwarted Barry Diller's plans to merge QVC with the Columbia Broadcasting System, Inc. (CBS).

In pursuit of acquiring more cable programming options, Ralph and Brian elected to position Comcast Corporation as a major supporter of QVC in its recent bid to acquire ownership of Paramount Communications. The takeover bid was unsuccessful. However, Comcast continues to seek other partners to invest in future programming opportunities. It also owns interests in other cable programming services including E! Entertainment, Turner Broadcasting, Viewers Choice, and Music Choice, a CD-quality music programming service.

Both Ralph and his son, Brian, are highly regarded in the cable television industry. A unique father-and-son team leading a major corporation, they are known for the complete trust they have in one another. But Ralph Roberts is not only a savvy businessman and thoughtful mentor, he is also an involved community leader. He has been a member of a number of boards of directors, including those for the Albert Einstein Medical Center, the National Conference of Christians and Jews, the Greater Philadelphia Urban Affairs Coalition, the Brandywine Museum and Conservancy, the Greater Philadelphia Chamber of Commerce, the World Business Council and the Philadelphia Orchestra. He has also served as Chairman of the Walter Kaitz Foundation.

Roberts has been honored with numerous awards. Some of them include the Americanism Award from the Anti-Defamation League of B'nai B'rith in 1986, the Brotherhood Award from the National Conference of Christians and Jews in 1989, the Walter Kaitz Foundation Award (for outstanding service to the cable industry) in 1990, and the National Cable Television Association's (NCTA) Distinguished Vanguard Award for Leadership in 1993. In addition, Roberts is a 1993 inductee into *Broadcasting & Cable* magazine's Hall of Fame.

Ralph Roberts and his wife have five grown children.

u contributed by Valerie Switzer

Clarke, Arthur Charles (1917 –)

English author and futurist. Best known for science fiction works particularly recognized for their plausibility. These include his 1968 novel, *2001: A Space Odyssey*. He is also noted for his 1945 prediction of orbital communication satellites.

Clarke was born in Somerset, England, on December 16, 1917, and developed a lifelong interest in astronomy while in his teens. At the same time, he became a fan of science fiction novels. He combined these two passions into a formidable career.

At the age of nineteen, Arthur Clarke joined the English civil service. In 1937, he helped found the British Science Fiction Association, and regularly contributed articles to amateur publications affiliated with the Association. Clarke became a Radar Instructor and Flight Lieutenant in charge of the first ground control approach radar unit with the Royal Air Force during World War II. Throughout his wartime service, he continued to contribute articles to technical magazines.

In 1945, when Clarke was 28, he published a now-famous article in the periodical *Wireless World.* In the article, Clarke made his incredible, and accurate, prediction that space communications satellites would someday orbit the Earth, providing the capability for worldwide communications. He was the first to suggest the existence of a geostationary orbit, 22,300 miles above the Earth, where communications satellites could circle at the same speed as the Earth's rotation. That geostationary orbit is now known as the Clarke Orbit.

Following the war, Clarke enrolled in college in London to study physics and mathematics. After earning his bachelor's degree, he was pursuing graduate studies when he was appointed Assistant Editor of the journal *Science Abstracts*. In 1950, Clarke left his job to devote more time to his writing career. He began writing scientific books in 1950 and science fiction a year later. He has since authored and co-authored more than 70 fiction and nonfiction books.

Arthur Clarke made himself known as a champion of space exploration in books such as *Interplanetary Flight* (1950) and *The Exploration of Space* (1951), for which he won the International Fantasy Award for non-fiction. His most famous novel, *2001: A Space Odyssey* (1968), was written with Stanley Kubrick and later produced as a popular motion picture. The sequel, *2010: Odyssey Two,* was also made into a film.

Since the mid-1950's, Clarke has lived in seaside Colombo, Sri Lanka. In 1962, he was honored in New Delhi with the Unesco Kalinga Award for his lifetime achievements in popularizing science. Although Clarke is now in his late 70's, he continues a full schedule. One of his latest non-fiction works, entitled *How the World Was One*, is a history of global telecommunications. He is also reportedly discussing plans to develop a musical based on his favorite novel, *The Songs of Distant Earth*.

u contributed by Susan P. Sanders

Telecommunications Act of 1996

For 62 years, the basis of communication law in the United States has been legislation that was written at a time when the telegraph, telephone, and radio were the only means of electronic communication. On February 8, 1996, President William Clinton signed into law a rewrite of the 1934 Communications Act.

For 62 years, the basis of communication law in the United States has been legislation that was written at a time when the telegraph, telephone, and radio were the only means of electronic communication. On February 8, 1996, President William Clinton signed into law a rewrite of the 1934 Communications Act.

Modifications and additions to the 1934 Act have set national policy for segments of the telecommunications industry. In 1982, Judge Harold Greene determined the fate of the telephone companies when he handed down his Modified Final Judgment (MFJ) that decreed the breakup of AT&T. In 1984, local telephone service was provided by the regional Bell operating companies and AT&T was in the long distance business. Since that time, Judge Greene has set and enforced national policy regarding telephone services.

In 1984, the Cable Communications Policy Act was amended to the 1934 Communication Act to proscribe national policy regarding the cable television industry. The Cable Act of 1984 was changed with the passage of the Cable Television Consumer Protection and Competition Act in 1992, and in 1994 Congress made an attempt to rewrite the Communications Act of 1934. Although it fell short, the momentum of that effort carried over through 1995 and into 1996.

In mid-1995 it seemed certain that the U.S. House of Representatives was close to passing it's version of a bill that would result in massive changes in the telecommunications industry and create the information superhighway in the United States. A Senate version had been passed on June 15, 1995 and it appeared that the legislative effort was about to bear fruit. However, many industry leaders and some legislators weren't happy with the results and the new law had to wait.

Each of the industries or technologies being gathered under the umbrella called "telecommunications" is in itself huge. Each one - entertainment, electrical utilities, computers, television, cable TV, radio, telephone, and wireless communications - has manufacturing, sales, and distribution networks with large numbers of employees and almost $1 trillion in annual revenue. When congress rewrites the rules for a group of industries that generates 1/6 of the nation' s annual revenue and touches the lives of almost every person in the United States it has to be done right. In addition to the impact it will have on current employees and customers, House Speaker Newt Gingrich characterized the Act as a jobs bill that could create 3.4 million new jobs.

By most accounts, the Telecommunications Act of 1996 was the starting pistol that the industry had clamored for. Within days following the February 8 signing by the President, CEOs of radio, television, computer, CATV, and telephone companies had lauded the effort and the results, promising consumers new, better, and more of everything, but at lower prices.

Some of the first companies off the starting line were radio broadcasters. Once the Act changed the ownership restrictions for radio stations, Triathlon Broadcasting laid out $37 million to buy 7 stations while Jacor Communications bought Citicasters for $770 million and Noble Broadcast Group for $152 million, making Jacor one of the country's largest owners of radio stations.

Radio, broadcast television, CATV, and newspapers all have new rules of ownership that will encourage consolidation into conglomerates that will be even larger than in the past.

The Act also had immediate effects on other industries. Within five days of the signing ceremony, Ameritech said it had signed up 126,000 customers for its long-distance cellular service. Merger and partnership talks that had been tentative before the signing ceremony were kicked into high gear. MCI and Rupert Murdoch can now make use of their satellite slot to deliver up to 200 channels of television nation-wide. AT&T has entered into the satellite TV business, and NYNEX and Bell Atlantic are conducting merger talks. Tele-communications Incorporated (TCI), Comsat, and Time Warner are now assured that the $175 million they spent in November of 1995 for high-speed cable modems was a smart investment, not a gamble.

President Clinton, in remarks made at the signing ceremony, equated the act creating the information superhighway with the Interstate Highway Act of 1957 when he said, …that same spirit of connection and communication is the driving force behind the Telecommunications Act of 1996.

Although the FCC has six months to create the rules based on the legislation, some changes are clear and present.

CATV
Rates for small systems with less than 50,000 customers or unaffiliated companies with less than $250 million in annual revenue are deregulated immediately. For large cable companies, rates for extended basic service are to be deregulated in 1999. Effective competition by any telephone company delivering a comparable cable television service also means immediate deregulation for the affected cable system. The delivery of television programming by Direct Broadcast Satellite (DBS) is not considered in the Act to constitute effective competition for a cable system, so cable systems competing with DBS will not be deregulated.

CATV companies are barred from buying telephone companies, except in rural areas with less than 35,000 people. Cable companies can, however, purchase up to 10% of a telephone company.

The Act does allow cable companies to provide local telephone service, a provision that overrides state and local regulations that have prevented CATV companies from getting into the local telephone business. Local exchange carriers (LECs) are also required to work with any new local telephone companies to provide interconnection, number portability, dialing parity, and access to rights-of-way.

Cable companies are required to scramble any program that a subscriber feels is not suited for children. Fines for obscenity were also raised from $10,000 to $100,000. The Act also gives CATV operators the right to refuse public-access and leased-access programming that the operator feels is obscene or indecent.

The Act also requires the FCC to act upon a must-carry complaint within 120 days of filing.

Broadcast Television
Three major changes occur in broadcast television. First are the ownership rules. The 12-station cap on ownership was eliminated and the allowed coverage limit was raised from 25% to 35%, meaning that a single broadcaster, no matter how many television stations are owned, can reach a maximum of 35% of the TV homes in the United States. Previous ownership rules were retained that forbid companies from owning two television stations in the same market, or cross-ownership of television stations, newspapers, and CATV systems. The Act does, however, allow cross-ownership of a broadcast network and a CATV system in the same market. Rules preventing a company from owning two networks were relaxed so that an existing network can create a new network but cannot purchase a network already in existence.

The second major provision affecting television broadcasters is the requirement that they develop a rating system for programs based on whether the material is violent, sexual, or indecent in nature. Broadcasters must then transmit an electronic signal that contains the rating for each program. Following development and proof of the technology, every television set sold in the United States will be required to incorporate a violence microprocessor (V-chip) that will read the rating signal and block any programs designated as undesirable by the viewer.

The third change for television broadcasters is the length of time between license renewals. A license will now be good for eight years and broadcasters can assume their license will be renewed unless they have had serious violations or exhibited a pattern of abuse.

Telephone
Telephone companies, like CATV companies, are also prevented from buying cable systems, except in rural areas with fewer than 35,000 people. And they too can own a maximum of 10% of a cable company.

Telephone companies can now provide video programming in their service areas and can choose how they want to be regulated. They can be classified as a CATV system, common carrier, or open video system. The open video system designation means that a telephone company would have to make their channel capacity available to independent programmers without discrimination. As an open video system, a telephone company would not have to obtain a local franchise. They would be required to comply with the same network non-duplication, syndication, exclusivity, must-carry, and retransmission consent rules that govern CATV systems.

LECs, made up mostly of the regional Bell operating companies (RBOCs), are now permitted to provide long-distance services, and the long-distance providers, the big three being AT&T, MCI, and Sprint, can enter the local telephone market.

Before they can provide long distance service, the LECs must comply with a checklist of conditions that cover such items as interconnection for competing companies, sale of individual services to other LECs and long distance companies, dialing parity, and the resale of local service to long-distance companies. The LEC must also prove that there is competition for their local residential and business customers before they can enter the long-distance arena.

The Act also maintains the concept of universal service by requiring all telecommunications companies to contribute to a fund that will be used to ensure equal access for everyone.

Radio
Previous limits on national ownership were eliminated and ownership rules for local stations were changed to allow a single company to own more stations. In large markets with 45 stations or more, one company can own eight stations but is limited to five of each type (AM or FM). In markets with 30-44 radio stations, one company can own seven stations and a maximum of four of each type. Ownership in markets of 15-29 stations is limited to six, with no more than four of each type. In markets with 14 or fewer stations, the rules limit ownership to a total of five stations or 50% of the stations in a market, whichever is less, and no more than three of each type.

Electric Utilities
Although the only direct reference in the Act to utilities regards the requirement that they provide access to their rights-of-way, this single item could mean that electric utilities have been given an opening to partner with companies who need access to the large fiber-optic networks already owned by many utilities. Utility companies, long thought to be the dowdy and unglamorous members of the telecommunication industry grouping, not only have fiber in place, they also have final mile connections to virtually every home in the United States and can play a large role in the building of the information superhighway.

Communications Decency Act
The Communications Decency Act (CDA) was introduced by Senator James Exon (D-Nebraska) and Senator Slade Gorton (R- Washington) and incorporated as an amendment to the Telecommunications Act.

The CDA targets the small portion of content on the Internet that delivers what it terms indecent material. The CDA includes fines up to $250,000 and jail terms up to two years for using telephone lines and computers to transmit indecent material, including text and images, to a person under the age of 18.

Many people who had been active proponents of the Telecommunications Act because they perceived it as an essential step toward the realization of the information superhighway became active opponents once the CDA was added.

The Internet, an important part of what will become the information superhighway, began as a self-regulated communication channel to enable the free-wheeling interchange of information and ideas. For this reason, among others, this legislation to limit the content of information on the Net has been met by a vocal opposition that bases their concerns on the First Amendment right to free speech.

Within hours of being signed into law, the Communications Decency Act was challenged by the American Civil Liberties Union (ACLU) and 19 other groups. In addition, on February 9, Senator Patrick Leahy (D-Vermont) introduced legislation to eliminate the CDA.

The Future

The new Telecommunication Act has been under construction for several years, causing companies to act cautiously and conservatively until they knew how they fit into the road map for the information superhighway. While it doesn't throw the gates wide open or tear down all of the previous restraints, the Telecommunications Act of 1996 does provide a degree of opportunity for change and growth that has been absent since 1934.

In this year when the telephone is 120 years old and the computer turns 50, it is fitting that each should face the future with a new set of regulations to guide them in directions that even their developers, Alexander Graham Bell, Charles Babbage, and John V. Antanasoff, had never imagined.

u contributed by Paul Stranahan

Redstone, Sumner M., (1923-)

American billionaire and business executive. Chairman and majority owner of Viacom Inc., one of the world's largest media and entertainment companies. Also credited as a pioneer in developing the multiplex theater venue.

In 1979 movie theater magnate Sumner Redstone found himself in a drama more likely to occur on the silver screen than in reality. A Boston hotel fire had left Redstone badly burned and hanging from a third-story window sill. Though injured, the 56-year-old executive managed to hang on until rescue workers saved him. Perhaps no other episode in Redstone's life better epitomizes the tenacity and determination he displays as a business leader than this real-life cliffhanger. Eight years after the hotel incident, Redstone used his will to succeed to lead his theater chain in an aggressive take over of Viacom. Today, Redstone is considered one of the most powerful and influential men in media.

Redstone was born in Brighton, Massachusetts, a Boston suburb, to Michael and Belle Rothstein, both of whom were born in the United States and were of German and Russian descent, repectively. His father was a linoleum salesman. Later, he became a successful Boston nightclub owner. In a move that would at once set the stage for the family's business success as well as foreshadow his son's own movie theatre innovations, Michael Redstone opened one of the first drive-in theaters in the country. The idea to display movies on outdoor screens -- both novel and practical -- quickly caught on with the American public. Michael Redstone soon opened more theaters along the country's east coast.

As a boy, Sumner Redstone excelled in school. He attended Boston Latin School, where he was captain of the debate team. At age 17, he was accepted into Harvard. He was granted his degree in just two and a half years and became part of a United States intelligence operation as a code-breaker, deciphering Japanese messages.

After the war, Redstone returned to Harvard and received his law degree. He married Phyllis Raphael in 1947. From 1947 to 1948, Redstone was Law Secretary at the U.S. Court of Appeals for the Ninth Circuit. From 1948 to 1951, he was a Special Assitant to the U.S. Attorney General. At the age of 28, Sumner left the Justice Department to become a named partner in a Washington, D.C. law firm. Three years later, Redstone found himself disillusioned with the legal profession and returned to the family theater business, which had been run by his father and younger brother, Edward.

Using his litigation experience, Redstone helped bolster the viability of the drive-in theater business by forcing studios to honor the theatre's right to show first-run pictures. The family's movie theater chain, originally called Redstone Management and later changed to National Amusements, Inc., showed steady growth through the 1960's and 1970's, eventually becoming an East Coast giant. Today, the company owns close to 1000 screens in the U.S. and the United Kingdom, which produce approximately $250 million in revenue. Part of the reason for Redstone's large personal wealth is because instead of leasing land for his theaters, he buys it outright.

Redstone's lasting contribution to the movie theater business may be his pioneering development of the multiplex. Rather than have a theater dedicated to one movie, a multiplex offers an audience many movie screens under one roof. Today, National Amusements owns the copyright to the word multiplex.

By the l970’s, Redstone had become a major investor in major media companies such as Twentieth Century Fox, Columbia Pictures and MGM. His investments paid off handsomely. In 1987, Redstone made his most aggressive stock market bid. Concerned about the future of movie theaters, Redstone wanted to diversify into other media. He turned his attention to Viacom, with its media holdings which included cable networks such as MTV and Nickelodeon. Though conventional wisdom held that MTV had reached its pinnacle and would fall to soon fall to wayside as an 1980’s fad, Redstone forged ahead with the take over bid. Today, MTV alone pulls in nearly a quarter-billion dollars in revenue annually and its reach is global, and Nickelodeon is the number one basic cable service.

A highly leveraged purchase, Redstone provided only $500 million cash for Viacom’s $3.4 billion price tag. The rest was borrowed. Despite the large debt, by 1992 Redstone and Viacom CEO Frank Biondi managed to restructure debt and greatly reduce the overall interest payments. In 1994, however, Viacom once again took on debt in its $10 billion acquisition of Paramount Communications and Viacom’s subsequent $8 billion aqcuisition of Blockbuster Entertainment Corp. The takeover created a global media empire.

A *U.S. News and World Report* article has referred to Redstone as America’s hippest grandpa because of his holdings in MTV and Nickelodeon. These networks command a large share of the television audience between 2 and 24 and MTV in particular remains a strong influence in popular culture.

Still displaying the cutting-edge mentality that helped shape his success, Redstone looks toward interactive communications as the next big thing. He wishes to make Viacom a major producer of CD-ROM and multimedia content for interactive services of the future.

Despite being a billionaire, Redstone still lives in the modest three-bedroom house he bought in the 1950’s. He spends several days a week in New York, working at Viacom’s Time Square headquarters. He has two children, Brent and Shari, and five grandchildren. Both are members of Viacom’s Board of Directors and Ms. Redstone is Executive Vice President of National Amusements, Inc.

u contributed by Christopher LaMorte

Editor's Notes:
In January, 1996, Sumner Redstone fired Frank J. Biondi, Jr. and created an executive committee to oversee the operations of Viacom Inc. Analysts and investors were surprised by the ouster, and many people suggested that Viacom's woes cannot be blamed on Biondi's management style.

Doolittle, James H. (1942--   )

American cable television executive and active board member of several key industry organizations; currently president of Time Warner Cable*, the second-largest owner and operator of cable television systems in the United States.

James H. Doolittle was born on March 19, 1942 in Durham, North Carolina. In 1966 he earned a bachelor of science degree in business administration from High Point College in High Point, North Carolina. Doolittle is also a graduate of Harvard's Advanced Management Program.

After completing his BS, Doolittle joined Jefferson Carolina, a pioneering cable television company, where he was responsible for setting up cable television systems in the North Carolina towns Raleigh and Dunn. Doolittle joined American Television and Communications Corporation (ATC) as the Fayetteville, North Carolina system manager in 1970 and was promoted to regional manager in 1973. In 1977 he became division president for eastern operations and transferred to ATC headquarters in Denver. Doolittle became ATC's senior vice president of operations in 1983 and executive vice president in 1985. In June, 1988 Doolittle became president and chief operations officer of ATC.

In 1990 Time Warner Inc. created the Time Warner Cable Group to oversee its two subsidiary cable companies--ATC and Warner Cable. Both Doolittle and James L. Gray*, the Warner Cable president, reported to the Cable Group's chairman and president, Joseph Collins.

ATC and Warner were combined to form Time Warner Cable in 1992, and Doolittle was elected president in August of that year. Gray was named vice chairman and headed the company's corporate staff operations until 1994, while Doolittle was designated to oversee its field operations. Time Warner Cable is based in Stamford, Connecticut, where ATC had been located. It is the second-largest cable company behind Tele-Communications, Inc. (TCI), and serves over 11.5 million subscribers.

Doolittle serves on the board of directors for C-SPAN, the public affairs cable network that provides live coverage of US Senate and House proceedings; for Cable in the Classroom, an industry group which promotes educational cable programming in schools; and the Walter Kaitz Foundation. He also serves on the board and has served as Treasurer of Cable Television Laboratories, Inc. (CableLabs), the consortium that was founded to oversee the development and creation of high-technology initiatives in the cable television industry.

Doolittle is an avid gardener and horticulturist. He lives with his family in New Canaan, Connecticut.

u contributed by Geoffrey Rubinstein

Lewis, Robert J. (1930 -)

Retired cable television executive and a recognized pioneer in the cable industry.

When Robert Lewis began his career in the cable television industry in 1958, the practice of transmitting television signals through cable instead of the airwaves was in its infancy. When he retired in 1995, the industry was a giant that could deliver much more than television signals. Mr. Lewis has played in integral part in this phenomenal growth.

The youngest of three, Lewis was born in Mena, Arkansas. When he was four years old, Lewis' family moved to Texarkana, Texas, then to McAlester, Oklahoma the next year. After Lewis graduated as salutatorian from Haileyville High School in 1949, the family moved to Norman, Oklahoma, near the University of Oklahoma. Lewis and his brother, L.E., attended school there, where Robert majored in business administration.

While at college, Lewis lived at home with his family and worked at the local theater chain, where he met his future wife, Norma. The two were married in 1950 and moved into their own apartment. Eventually, Lewis became the manager for the chain's five theaters in Norman. In 1954, as part of his ROTC requirement, Lewis entered the army and was stationed at Fort Sills, Oklahoma. Before he left, however, Lewis had expressed an interest to his superiors at the theater chain, Vumore, that he was interested in the cable television (or, community antenna systems, as they were known at the time) businesses they also operated. I don't know if it was a vision or what, says Lewis of his early interest in cable television. His bosses at Vumore told him to check in with the company when he completed his ROTC requirements.

Two years later, Lewis did just that. However, before Vumore allowed him to work in their television operations, they asked him to manage a group of theaters located in Cuero, Texas. Two years later, he was given the chance to work at one of Vumore's cable systems in Clarkesville, Mississippi. The company relocated a somewhat reluctant Lewis several more times in the next few years to manage various cable systems in Texas and Oklahoma.

Working under cable pioneer Larry Boggs, by 1961 Lewis had become Vumore's first district manager and then its regional vice president. Lewis was responsible for more than 20 cable systems located in Oklahoma, Texas and Kansas. After another 10 years of hard work, Lewis was named executive vice president of the renamed company Cablecom-General. Within a matter of months, he became president and one of the directors of the company.

Having reached the pinnacle of success at Cablecom-General as well as sharing some philosophical differences with upper management, Lewis left the company for other ventures. In 1976, he was named president and chief operating officer of Jones Intercable, Inc. At the time, Jones was struggling to get limited partnership agreements off the ground. According to Lewis, the company needed a person with extensive experience operating cable systems, which he had. Three months after joining the company, Lewis managed to sign up a prominent brokerage firm to sell interests in Jones. Lewis proved himself to be a savvy negotiator while at Jones, brokering the acquisition of many cable systems. During Lewis's relatively short tenure at Jones, the company saw explosive growth. In the eight years that Lewis spent at the company, he saw the number of Jones subscribers skyrocket from 10,000 to 400,000.

But Lewis had aspirations of his own and he left Jones to start his own cable television venture, Lewis Communications, with 7,500 subscribers scattered throughout Colorado, Texas, Kansas and Nebraska. In 1985, Lewis also became president of Televents Group, Inc. Displaying his negotiating skills, Lewis helped broker the sale of Televents and its 130,000 subscribers to Tele-Communications, Inc. (TCI). Around the same time, he also sold Lewis Communications to TCI as well.

Not long after TCI's acquisition of the Televents and Lewis Communications, Lewis went to work for TCI, serving as vice president of corporate development. He worked under TCI head John Malone, who Lewis describes as brilliant. In this capacity, Lewis handled the acquisition of smaller cable systems by TCI. While in that role he helped add more than 2 million new subscribers to TCI's viewership. Today, TCI stands as the largest American cable operator with cable systems in 48 states.

In 1993, Lewis decided to slow down a bit and became a consultant for TCI. He officially retired in September, 1995. At his retirement dinner, an executive at Time Warner described Lewis as always fair in dealing with people, tough, but fair. His word is his bond. Upon reflection, Lewis believes that those attributes have helped him achieve the remarkable success he has had during his career.

Though Lewis plans to do some consulting work during his retirement, he plans to spend more time with his seven grandchildren. Retirement will also give Lewis time to spend on his hobbies including golfing and skiing. Lewis's other passion is collecting cars — expensive ones. His prize is a 1988 Mondial Ferrari convertible. The car reflects Lewis' career - right at home in the fast lane.

u contributed by Christopher LaMorte

Schotters, Bernard W. (1944-)

Communications executive and senior vice president of finance and treasurer of TCI Communications, Inc.

TCI is the largest cable operator in the U.S. today. More than twelve million cable television viewers subscribe to TCI-affiliated cable systems. The company's growth over the past decade has been remarkable. At the center of this large corporation's growth is Bernard Schotters, who is responsible for the financing requirements of TCI and its divisions. Additionally, he is treasurer for the company and head of its insurance/benefits, investor relations, real estate and facilities divisions.

Mr. Schotters graduated from Washington University in 1967 and received his MBA from Northwestern University's Graduate School of Management the following year. Schotters then served in the United States Navy for four years, holding the ranks of lieutenant and line officer aboard ship before entering the business world.

From 1977 to 1978, Schotters was president of Group W Cable, which at that time was jointly held by a number of cable operators. Before joining TCI in 1983, he also acted as vice president of Wells Fargo Bank and was involved in commercial lending.

The following years were important ones for TCI. In 1984, the company was experiencing significant growth, and was expanding into several major U.S. cities. By 1985, TCI acquired Group W, Schotter's former employer.

In 1994, TCI reorganized itself into four operating groups. These groups are responsible for different aspects of TCI: domestic distribution of cable and telephony, programming, international investments and operation and technology ventures. Mr. Schotters is responsible for the financing requirements of all of these divisions.

Schotter's responsibilities will no doubt continue to grow as TCI continues its expansion into new areas of technology, such as projects to provide telephone service over its cable network. In a joint venture with Sprint, Comcast and Cox Communications, TCI plans to bundle local telephone, long-distance and wireless communications with cable services into a single network. The installation of fiber optic cable in its distribution network and other capital-intensive, high-tech improvements to TCI's infrastructure will keep Schotters busy for the foreseeable future.

Bernard W. Schotters is currently a member of the National Association of Securities Dealers 1994 Issuers Affairs Committee. He also serves as a consultant to the National Cable Television Association (NCTA). In 1992, he received the NCTA's President's Award.

Mr. Schotters and his wife, Nancy, live in Denver, Colorado. He is the father of three.

u contributed by Christopher LaMorte

Barton, Peter (1951 -   )

Telecommunications executive, current chief executive officer of Liberty Media Corporation and Executive Vice President of Tele-Communications, Inc.

Today Tele-Communications, Inc. (TCI) is the largest multiple system operator in the United States. More viewers watch cable television on a TCI-owned system than any other. But without Peter Barton, there wouldn't be anything to watch. He is the head of Liberty Media, the programming arm of TCI.

Barton was born on April 6, 1951 in Washington, D.C. Well educated, he graduated from Columbia University with a bachelor's degree in 1971 and a master's degree the following year.

Early in his career, Barton was more interested in politics than in television. He was a member of the staff of the governor of New York, Hugh Carey, from 1975 to 1980, serving as the Deputy Secretary to the governor.

In 1983, Barton returned to college, receiving an MBA from Harvard's Advanced Management Program. He used his business education when he was hired in 1984 as vice president of TCI and put in charge of acquiring urban cable systems. After two years in that capacity, Barton moved to Minneapolis, Minnesota, where he was president of Cable Value Network until 1989.

Barton began working as a programming executive for TCI in 1988 and was senior vice president of programming for TCI until 1991. When Liberty Media Corporation was incorporated by TCI in 1991 as a separate, publicly held company, Barton served as president, CEO and director of the division. Liberty Media Corporation offered Encore, a channel that provided a variety of feature movies. On any day viewers could tune in Encore and find a Western in the morning, a sci-fi thriller in the afternoon and a tear-jerker in the evening. The wide selection of films Encore offered is one way that Liberty helped cable television fulfill its promise of offering quality entertainment for everyone, regardless of one's taste. Liberty merged with TCI in 1994.

Mr. Barton's influence in today's media is widespread. In addition to his duties related to TCI and Liberty Media, Mr. Barton serves on the board of directors of Turner Broadcasting System, Inc., Discovery Communications, Inc., Black Entertainment Television, Liberty Sports, Inc. and Encore Media Corporation.

u contributed by Christopher LaMorte

Romrell, Larry (no dates available)

American telecommunications executive, current Executive Vice President and Chief Executive Officer of TCI Technology Ventures, Inc.

Today’s telecommunications technology is marked by rapid change. Even the world’s largest communication providers are faced with the daunting task of keeping up with that change and providing technological improvements to the public. Larry Romrell helps Tele-Communications, Inc. (TCI), the largest provider of cable television services in the U.S., do so.

Mr. Romrell is responsible for TCI’s investment in new technology. He has been on the cutting edge of technology since the 1970’s. That’s when he oversaw TCI’s deployment of the first portable uplink facility in the United States. This uplink facility allowed TCI to provide a satellite feed for the Lake Placid and Sarajevo Olympic games.

As head of TCI’s technology division, Mr. Romrell’s input is crucial for the company’s participation in new technology ventures. For instance, he is an important player in TCI’s Teleport, a telephone communication venture. Also, TCI, along with Microsoft Corporation, is involved in an interactive television test in Seattle, Washington. In another high-tech venture, TCI entered into an agreement with Sprint, Comcast, and Cox Enterprises in 1994 to bundle local telephone, long-distance and wireless communications services into a single network. Such new technology efforts keep Mr. Romrell well occupied at TCI.

An Idaho native, Romrell received his degree in electrical engineering from Idaho State University. Before joining TCI in 1961, he worked as an engineer for Columbia Pictures, Time Inc., and KBLI, Inc.

Mr. Romrell serves on the board of directors of Teleport Communications Group Inc., General Communications, Inc., Virtual I/O and Sega of America, Inc.

u contributed by Christopher LaMorte

Sparkman, J.C. (no dates available)

Retired communications executive, former executive vice president and executive officer of Tele-Communications, Inc. (TCI).

J.C. Sparkman is a visionary. As an executive of the largest cable television operator in the U.S., Mr. Sparkman saw beyond television's ability to amuse and entertain and believed in television's capacity to educate and enlighten. Born in rural Maud, Oklahoma, Mr. Sparkman has proven himself a guiding light in the development of advanced teaching methods via cable television technology.

Mr. Sparkman is the former chairman of the board for Cable in the Classroom. This organization is the cable television industry's program that offers educational initiatives for schools. Mr. Sparkman was so committed to the educational power of television, he spearheaded the TCI Education Project. The innovative project provides free educational programming in an effort to teach children about new technology.

But the educational commitment Mr. Sparkman displays moves beyond educating children. The J.C. Sparkman Center for National Teacher Training, named in his honor, provides teachers with free, state-of-the-art facilities to understand and master emerging technologies that will improve and expand their role as educators. The Denver-based center provides hands-on training to educators, school board members, administrative and district personnel, parents and students.

Another innovative project that Sparkman has been involved with is TCI's Schools of the 21st Century. This project also tries to maximize the resources that teachers have at their disposal and improve the ability of students to use the ever-growing number of electronic resources of today's world.

Mr. Sparkman sits on boards of directors of several organizations including Shaw Communications, ICT and Texscan. He is married and has three children and six grandchildren. J.C. Sparkman retired in 1995, giving him more time to enjoy his favorite pastime, golfing.

u contributed by Christopher LaMorte

Vierra, Fred A. (no dates available)

American cable television executive, current chairman and chief executive officer of Tele-Communications International, Inc., a subsidiary of Tele-Communications, Inc.

Tele-Communications, Inc. (TCI) is already the largest multiple system operator in the United States, with more than 12.7 million subscribers spread throughout 48 states. As the head of TCI's international division, Vierra is helping the company expand its reach into foreign cable markets. He is responsible for all international cable and programming operations.

Mr. Vierra began his career in cable television as executive vice president of investment banking for Daniels & Associates, a financial services provider for the cable industry. Daniels & Associates was founded by Bill Daniels, a respected cable pioneer.

Later, Mr. Vierra joined United Artists Entertainment Company (UAE), where he served as president and chief operating officer. As such, he oversaw the company's day-to-day operations and developed the company's long-term development strategy for UAE's cable television systems and movie theaters. In 1991, TCI added 86 cable systems to its operation by acquiring UAE. It was at this time that Vierra joined TCI.

Since becoming CEO and chairman of TCI International, Inc., Vierra has helped the company continue its tradition of growth by directing its international expansion. TCI entered into a joint venture with US WEST, a phone company, for projects in the United Kingdom. In Japan, along with Sumitomo Corporation, TCI has gained a foothold in the often xenophobic Japanese business community. In late 1994, TCI began cable operations in South America. TCI entered Argentina's cable market when it developed a partnership with CableVision, that country's largest cable operator.

With the globalization of communications and the advancement of technology, Mr. Vierra's position at TCI will no doubt continue to be a focal point for the company. His vision for the future calls for more growth in the international arena.

u contributed by Christopher LaMorte

Arakawa, Minoru (no dates available)

Japanese-born president of Nintendo of America who is credited with revitalizing the American home video game market.

By Christmas 1983, the home video game market had been pronounced D.O.A. The industry leader, Atari, had collapsed and its competitors soon followed. The public had no interest in newer, more expensive and sophisticated video game systems, particularly since better games -- the real incentive for buying a video game player -- were not forthcoming. Conventional wisdom deemed video games retail poison. Nintendo of America (NOA) President Minoru Arakawa, however, read the industry's vital signs differently.

Arcade video games, by contrast, were still a billion dollar industry. Arakawa was well aware of this. His company, producer of the arcade hit *Donkey Kong*, had done quite well in the arcade market. He knew that people, particularly young males, still loved video games. In addition, NOA's parent company Nintendo Co. Ltd (NCL) was enjoying sustained sales of its home video game system, the Famicon in Japan. Arakawa surmised there must still be some interest in home video game systems in America.

By studying the mistakes of video game manufacturers such as Atari, not to mention following his gut feeling in the face of pessimistic initial response, Arakawa made Nintendo a household word and a multi-billion dollar industry. Games such as *Super Mario Brothers* and *Donkey Kong Country* have become an integral part of American culture.

Arakawa, however, traces his roots back deep into Japanese culture and tradition. His father was the wealthy fourth-generation owner of a textile plant. When Arakawa's parents married, their families's combined land holdings made up 20 percent of Kyoto.

The youngest of three, Arakawa was raised in the formal aristocratic Japanese traditions. He and his siblings were taught proper manners and gentility. Arakawa's brother, the eldest child went into the family business, as was expected. Arakawa had more freedom to plan his life's course. He received a degree in civil engineering in 1964, and a master's degree, also in engineering, from Kyoto University.

Arakawa met his future wife, Yoko Yamauchi, at a society gathering in Kyoto. Yoko's father was Hiroshi Yamauchi, the head of Nintendo Co. Ltd. At the time Arakawa was living in Tokyo, working as an architect for a real estate developer. Though there had been some bad blood between the Arakawa and Yamauchi families, neither family objected when the two announced plans for marriage.

Though both Arakawa and his wife could have lived off of their family fortunes, Arakawa became dedicated to his job. In 1977, he and Yoko moved to Vancouver to oversee the development of a condominium project. Though the move was hard on the young couple, both economically and mentally, they persevered.

In 1979, Arakawa's father-in-law approached him with a business proposition. Impressed with the managerial ability his son-in-law demonstrated as a real estate developer, Yamauchi asked Arakawa to help him start an American subsidiary of NCL. Though NCL's sales of video games in Japan was good, Yamauchi wanted to compete in the American market. An American subsidiary would allow him to gain a foothold with American consumers. Because Yoko had watched Nintendo consume her father's life, she was reluctant to lose her husband to the company as well. Arakawa, however, eventually agreed to his father-in-law's proposition and he and Yoko moved from Vancouver to Englewood Cliffs, New Jersey to run New York-based Nintendo of America.

Though there were set-backs that threatened to sink the fledgling company, Arakawa with the help of his wife, established a sales team to market Nintendo coin-operated video games throughout the country. By 1981, the company had its first mega-hit, *Donkey Kong*. Other hits soon followed, including *Donkey Kong Jr., Popeye* and *Punch Out*. In order to save time in shipping games from Japan, Arakawa moved the company to a Seattle suburb. Later, they moved to Redmond, Washington.

In 1984, Nintendo set about marketing an American version of its home video game system, which was a tremendous success in Japan. The system, originally called the Advanced Video System (AVS), was designed to allow peripheral attachments, like keyboards and laser guns. The most important aspect of AVS, later renamed the Nintendo Entertainment Systems, or NES, were the games. One of the major mistakes of previous game systems were games that delivered sub-quality entertainment. Though retailers were leery of a new video game system, with the aid of aggressive marketing and a multi-million dollar advertising campaign that dissociated the NES from older games systems such as the Atari 2600, Nintendo's new game system caught on with consumers.

By 1992, Nintendo had become the leader of video game market, with an 80 percent share of the multi-billion dollar market. Nintendo launched two more video game platforms, the Super NES and the hand-held Game Boy. However, competition from more advanced systems such as Sega Genesis eroded Nintendo's market share. Sega had virtually tied Nintendo in 16-bit machines by 1994. In 1994, Nintendo executive vice president and Arakawa's close friend, Howard Lincoln was named Chairman of NOA. Some industry analysts felt that Yamauchi was expressing displeasure with Arakawa's overall effectiveness. Nintendo, however, contends that the appointment was done to create a power sharing structure at NOA's helm.

Arakawa is said to be soft-spoken and reserved. Like Lincoln, he prefers casual dress at the office. He also enjoys golf and fishing.

u contributed by Christopher LaMorte

Kalinske, Thomas J. (no dates available)

American businessman, currently President and CEO of Sega of America, Inc.

Thomas Kalinske has had his finger on the pulse of the American kid for nearly 25 years. He's helped pretty up Barbie doll sales; he's also revved up the profit margins of Matchbox cars. Kalinske's latest assignment may be his toughest, however. As president and CEO of Sega of America, Kalinske is entrenched in a video game war that pits his company against Nintendo, the established leader in the industry. Energetic as a eight-year-old on Christmas morning, Kalinske has risen to the challenge.

After receiving his bachelor's degree from the University of Wisconsin in 1966 and a master's of business administration from the University of Arizona, Kalinske went to work at J. Walter Thomson, a New York advertising firm. Later, he worked at Case & Krone. In 1972, Mattel hired Kalinske to boost sales of its famed Barbie doll, which had recently suffered its first sales decline since its introduction. Kalinske managed to turn the trend around. When he left the company in 1987, Barbie sales topped more than one-half billion dollars.

Universal Matchbox Group, maker of Matchbox cars as well other toys, hired Kalinske as president and CEO in 1987. In addition to the its famed die-cast cars, Matchbox also produced toys such as the talking Pee-Wee Herman doll. His marketing background was just what the company needed as sales began to drastically slump. Kalinske used fatherly insights -- he has five children -- to help develop products. For instance, Kalinske noticed that his young daughter enjoyed whispering secrets to her dolls. That gave Kalinske the idea for Baby Secrets, a doll that whispered back to its mommy.

His tenure at Matchbox was short-lived. In 1990, Kalinske was hired as CEO of Sega of America, a subsidiary of Japan's Sega Enterprises. Sega had just unveiled its Sega Genesis system, a 16-bit video game player. It was more powerful than Nintendo's NES, 8-bit machine. Sega's challenge was to tout its machine's technological superiority for all it was worth. At the time, Nintendo enjoyed nearly total dominance in the video game market.

Kalinske moved aggressively to wrest the video game market away from Nintendo. Kalinske slashed the price of the Genesis to make it price competitive with the less advanced NES. Additionally, and perhaps more importantly, Kalinske started a marketing campaign to make Sega look sleek and hip, and to paint NES as a children's game. Sega was portrayed as "cool," and NES looked like yesterday's news. The campaign was successful and Sega Genesis has virtually tied Nintendo in the 16-bit video game market, going head-to-head with Nintendo's 16-bit entrant, the Super NES.

Kalinske has positioned Sega to move beyond video games. With partner Tele-Communications, Inc., Sega launched the Sega Channel, which allows players to receive video games via their cable hook up. Sega is also interested in opening virtual reality theme parks.

Some industry experts, however, fret that Sega may be moving too quickly. With a market as fickle as teenagers, Sega could see its popularity disappear as quickly as it appeared. But if there's one thing that Kalinske knows, it's what kids want.

u contributed by Christopher LaMorte

Lincoln, Howard (no dates available)

American lawyer and businessman, currently the chairman of Nintendo of America and member of the board of directors of its Japanese parent, Nintendo Co. Ltd. (NCL).

As a boy, Howard Lincoln was painted by famed American artist Norman Rockwell for a Boy Scout Calendar. Perhaps no other image better represents the spirit of 1950's boyhood than that of the Boy Scouts of America. Today, of course, if Norman Rockwell wanted to capture the essence of an American boy, undoubtedly a Nintendo video game would be in the picture. Howard Lincoln is largely responsible for that fact.

Lincoln was born in Oakland, California. His father was an executive with the Pullman Company and his mother was a housewife. As a child, Lincoln was energetic and active, traits that he still retains. He entered the University of California at Berkeley in 1957. Though Berkeley would become a focal point of the nation's free speech and anti-war movements, Lincoln was not active in campus politics. In 1962, Lincoln was admitted to the University of California's Boalt Hall Law School.

Shortly after finishing law school, Lincoln joined the Naval Reserve. Before he left for officer's training in Rhode Island, he was hired by the Alameda County District Attorney's Office. While there, Lincoln worked with future U.S. Attorney General Edwin Meese.

While on active duty in the Navy, Lincoln worked as a judge advocate, stationed at Sand Point Naval Air Station in Washington. Lincoln worked on court martial cases, alternately defending and prosecuting naval deserters. While stationed in Washington, Lincoln met his future wife, Grace, a naval recruiting officer. After a six-month courtship, the couple married. By 1970, both had left military life.

Lincoln used his legal experience to secure a job at a Seattle law firm, Sax & MacIver. He specialized in banking and corporate law. While there, Lincoln became involved with Nintendo of America (NOA), an American subsidiary of Japanese toy manufacturer, Nintendo Co. Ltd. He was first retained by two NOA distributors to review licensing agreements between them and NOA. It was these two distributors who introduced Lincoln to NOA president Minoru Arakawa. In 1981, Arakawa retained Lincoln to trademark the *Donkey Kong* name and the game itself, which had become an extraordinarily popular arcade game. Though Lincoln had no formal experience with trademark law, he accepted the task. Lincoln and Arakawa took to each other immediately. The two worked closely to broker many early agreements between NOA and home video game manufacturers such as Coleco, who wanted to produce home versions of *Donkey Kong*. By 1983, in a move some considered risky, Lincoln left the security of Sax & MacIver, to join the fledgling video game company as senior vice president.

Since 1985, when it launched its home video game the Nintendo Entertainment System (NES), NOA has grown tremendously. By 1992 it had corned an 80 percent stake in the multi-billion dollar video game market. Sega Genesis, however, managed to virtually tie

Nintendo's U.S. market share in 16-bit game machines by 1994. By 1995, Nintendo had three video game platforms: the NES, Super NES and the hand-held Game Boy.

In 1994, Nintendo Co. President Hiroshi Yamauchi appointed Lincoln as Chairman of NOA. The company said this move allows Lincoln and Arakawa to share responsibility for running the company.

An avid salmon and fly fisherman, Lincoln likes to take at least one fishing trip a year to Alaska to practice his sport. It is an apt sport for the man who helped hook American kids on *Super Mario Bros*. and *Donkey Kong Country*.

u contributed by Christopher LaMorte

Liptak, Gregory J. (1940-)

Cable television executive and co-founder of CTAM, the Cable Television Administration & Marketing Society; currently Group President of Jones International, Ltd., and president of the Product Information Network, Jones Satellite Networks, Inc., and Jones Programming Services, Inc.

Gregory James Liptak was born on January 4, 1940 in Streator, Illinois to Clarence John and Genevieve Ann Liptak. He earned a bachelor of marketing degree from the University of Illinois in Urbana in 1961. After serving as first lieutenant in the U.S. Army Signal Corps from 1961-1963, Liptak returned to Urbana to receive an MA in communications in 1964.

Liptak developed an interest in communications at an early age and worked at the local radio station during high school. After college, he became the news director at WDZ (AM) in Decatur, Illinois. In 1965 Liptak made the jump from radio to television when he was appointed assistant news director at WAND-TV, also in Decatur. Liptak's career in cable began a year later when he joined Cox Cable as the assistant manager of the Lakewood, Ohio system near Cleveland. When the cable operation closed in 1968, Liptak stayed in the cable industry and moved to LVO Cable in Tulsa, Oklahoma. When he entered the cable industry, Liptak says he "was confident that we had a product that would be of great appeal to the television consumer," but had no idea that there would be so much product available or that cable would develop interactive technology.

Liptak's career in cable took him throughout the southwest until he joined Jones Intercable as vice president of operations in 1985. At Jones, Liptak has served as the president of Jones Intercable, Inc., president of Jones Spacelink, Ltd., and most recently as Group President of Jones International, Ltd. Using his self-described "free and open" management style, Liptak oversees the Product Information Network, a 24 hour infomercial network; Jones Satellite Networks, Inc., which provides satellite delivered radio formats to nearly 1,000 radio stations in the U.S.; and Jones Programming Services, Inc., which arranges for all of the programming services carried on Jones Intercable systems in the United States. Jones Intercable, Inc. is one of the largest cable providers in the country.

In 1975, Liptak began working with Gail Sermersheim to found the Cable Television Administration & Marketing Society (CTAM). Now the Southeastern Regional Vice President at HBO, Sermersheim also founded Women in Cable and served as the second president of CTAM. Liptak was the first president of CTAM and received the first Roy Mehlman Award from the society for his work as a founding member. Without hesitation, Liptak says that founding CTAM is his greatest professional achievement. The society now boasts over 5,000 members.

Liptak is active on the Board of Directors of the Community Antenna Telecommunications Association (CATA), C-SPAN, Cable In The Classroom, and the National Cable Television Cooperative. He believes firmly that cable has the ability to become the "primary wire into the home," depending largely on what level of connectivity is allowed by federal regulators.

Married to his wife Stephanie since 1966, Liptak enjoys travel and tennis in his spare time. Their daughter, Christine, is completing an MBA at San Diego State and their son, Gregory, is the Western Division Training Director for the SEGA Channel.

u contributed by Natalie D. Voss

O'Brien, James B. (no dates available)

Cable television executive and co-author of The System Manager; currently president of Jones Intercable, Inc., one of the largest cable system operators in the United States.

James B. O'Brien was born in Berea, Ohio to James and Blanch O'Brien. He earned a bachelor degree in communication journalism from Xavier University in Cincinnati, Ohio and a Master's degree in public affairs from the Graduate School of Public Affairs at the University of Colorado.

After college, O'Brien worked in government and politics before joining Jones Intercable's franchising campaign in Longmont, Colorado in 1982. When the effort to build a franchise in Longmont, Colorado ended, O'Brien was named system manager for Jones in Brighton, Colorado and Gaston County, North Carolina. At the time, O'Brien "viewed cable as being a winner for the American consumer" but says he never dreamed that cable would grow to be such a large and successful industry.

Before being appointed president of Jones Intercable, Inc. in 1989, O'Brien served as division manager for southeastern cable operations. He was also the director of Operations, Planning and Analysis for the Office of the President/CEO and was Fund Vice President for the Fund 12-BCD Venture at Jones.

O'Brien's early work in cable included developing a competitive business plan for Jones Intercable, Inc. in the tight telecommunications environment of the United Kingdom. His ability to communicate, collaborate, and find solutions was instrumental to the success of a restructuring plan he helped develop at Jones in the mid-1980's.

O'Brien is actively involved with several major industry associations, including CableLabs, Inc., the Cable Television Administration & Marketing Society (CTAM), the Walter Kaitz Foundation, and the Society of Cable Pioneers in the United Kingdom. He is also a member of the Society of Cable Television Engineers and Women in Cable/Telecommunications. CTAM and Women in Cable have both recognized O'Brien for his contributions to the cable industry, which he believes in the future will "have a competitive advantage due to its broadband network." O'Brien envisions using cable to share the great treasures of the world via the Internet and the World Wide Web.

O'Brien's childhood hobbies included playing sports, building model trains, photography, and making music on piano and drums. During his spare time, O'Brien still enjoys photography and playing drums. He also spends time mountain biking, skiing, and in-line skating. He and his wife, child psychologist Dr. Cathy Lines, are also kept busy raising their two young sons, James and Sean.

u contributed by Natalie D. Voss

Bell Canada International Inc. (BCI)

Bell Canada International Inc. (BCI) is an international investment subsidiary of Bell Canada Enterprises Inc. (BCE).

Bell Canada International Inc. (BCI) is an international investment subsidiary of Bell Canada Enterprises Inc. (BCE). BCE was formed in 1983 by Bell Canada to act as a parent company and to separate Bell Canada's unregulated businesses from the regulated telephone service carriers. BCE's subsidiaries and associated companies provide telecommunications services to 70 percent of the Canadian population. BCI's business is to seek and develop investments in international telecommunications markets that are compatible with BCE's telecommunication activities. Currently, BCI oversees BCE's investments in telecommunications services (including telephone, cable television, and cellular) in the United Kingdom, the United States, New Zealand, the Far East, and South America.

As a subsidiary of BCE, BCI's history is necessarily that of Bell Canada from its inception to the creation of BCE and the formal division of the subsidiaries at that time. As in the United States, the beginning of the telephone industry dates back to the discovery of the telephone by Alexander Graham Bell in 1876. Bell, a Canadian living in the United States, began the Bell Telephone Company in the U.S., while his father brought the invention back to Canada. Canada's first telephone exchange began business in 1878 in Hamilton, Ontario. Bell of Canada, known informally as Bell Canada, was created by the Canadian Parliament in 1880. This move consolidated Bell's original company with several smaller companies. The early years of Bell Canada's history consisted of rapid expansion and acquisition of several other small telephone companies. By 1881, the company had exchanges in 40 cities, and by 1890, they were offering long-distance service over 3,670 miles.

The original Bell of Canada company was owned in part by Bell Telephone in the United States, and later by Bell Telephone's parent, the American Telephone and Telegraph Company (AT&T). In 1890, AT&T owned 48% of Bell Canada's stock, but over the years, Canadians began buying more and more of the stock. In 1925, Canadians owned 94.5% of the stock and by 1933, AT&T was no longer allowed to purchase any additional stock. In 1975, all ties to AT&T were severed.

In 1895, Bell Canada incorporated its manufacturing arm, Northern Electric & Manufacturing Company Limited, but it remained partially owned by AT&T's Western Electric. In 1924, dial service was introduced reducing the reliance on operators to complete telephone calls. During the late 1920s and early 1930s, remarkable advancements enhanced the telephone system, including phone service to Britain via the United States and long-distance calling between Montreal and Vancouver using an all-Canadian route.

Although the Great Depression reduced the demand for phone service, the advancements in technology and international business that resulted from World War II increased the need for instant communication. By 1945, Bell Canada had installed its one millionth telephone. The 1950s and 1960s saw Bell Canada continue to acquire or merge with other major telephone providers throughout the country. In 1957, Bell acquired a 90% interest in Northern Electric from AT&T's Western Electric. The buyout was completed in 1964.

During this time, new leadership emerged in the form of A. Jean de Grandpre, who believed the company's future lay in diversification. At first, Bell stayed in related fields, investing in a satellite joint venture (Telesat, 1970) and forming Bell-Northern Research Ltd. (1971) to consolidate its research and development efforts and Tele-Direct (1971) to consolidate the company's directory publishing operations. By 1973, de Grandpre was president of Bell Canada, and in 1976, he became chairman and CEO.

Also in 1976, Bell Canada created Bell Canada International Management, Research and Consulting Ltd., known simply as BCI. This company replaced the Consulting Services Group that had been founded in the mid-1960s to offer expertise in telecommunications management and technical planning. BCI handled dealings with common carriers, private corporations, defense companies, contractors, manufacturers consultants, and Bell's own equipment manufacturer, now known as Northern Telecom. In addition, BCI's business took it from underdeveloped third world companies in the Middle East and Africa to sophisticated telecommunications companies in the United States and Europe.

Under de Grandpre's leadership, Bell Canada soon controlled nearly 80 other companies. To gain better control over this varying group of businesses, de Grandpre created Bell Canada Enterprises in 1983. BCE became a holding company for all of these companies and allowed regulated Bell Canada to be separated from the other non-regulated businesses. In addition, de Grandpre believed that the restructuring of the company would give the company necessary flexibility for the increasingly competitive telecommunications market.

Following the directions of de Grandpre, BCE began expanding it interests to include businesses involved in energy, real estate, printing and packaging, mobile and cellular communications, and financial services. At first, this expansion resulted in huge profits and BCE became the first Canadian business to earn a net income of more than C$1 billion. But eventually problems began to develop. In 1985, a real estate subsidiary, BCE Development Corporation, failed. Poor returns were also reported in the printing and oil and gas investments.

At the same time, the Canadian Radio-Television and Telecommunications Commission (CRTC) found fault with Bell Canada's rates and ordered it to refund millions of dollars in excess payments and to lower its long distance rates. Under all of these pressures, de Grandpre stepped down as CEO of BCE and was replaced by J.V. Raymond Cyr in 1989. To restore the public's faith and to be able to respond to the increasing competition in the telephone services arena, Cyr decided to reevaluate the types of businesses in which BCE was involved. The decision was made to maintain the company's interests in telecommunications services and equipment, as well as financial services, but to divest itself of all other non-telecommunication businesses. The financial services were dropped in 1994 to maintain an emphasis on the telecommunications business.

In 1992, BCE leadership again changed when the job of CEO went to L.R. "Red" Wilson.

Wilson put together his own team of leaders and set out to restore BCE's reputation, with a focus on customer service and telecommunications technology. Derek Burney, a former ambassador to the United States, headed up BCE's international unit, BCE Telecom International Inc. During 1993, Burney entered into a partnership with Jones Intercable Inc., one of the largest cable television companies in the United States, to develop cable television/telephone service in Britain. In February of 1994, BCE Telecom International Inc. and Bell Canada International (BCI) were merged and became Bell Canada International Inc., retaining the BCI acronym and Derek Burney as its head. The new BCI's charge was to continue to seek out and develop investments in international telecommunication markets. In March of 1994, BCI and Jones Intercable Inc. joined with Cable and Wireless PLC to form Britain's third-largest cable-television company. Based on the success of their partnership, in 1994 BCI decided to buy a 30% interest in Jones Intercable Inc.

In addition to BCI and Jones Intercable Inc., BCE's principal subsidiaries and affiliates currently consist of Bell Canada, the country's largest telecommunication company; NORTEL (formerly Northern Telecom Ltd.), the second largest manufacturer of telecommunication equipment in North America; Bell-Northern Research Ltd., the largest private industrial research and development organization in Canada; and BCE Mobile Communications Inc., a cellular/paging/mobile data company. BCE also owns or has interest in several other Canadian telephone companies, a telephone directory publisher, and overseas communication companies. Under Red Wilson, BCE has become a successful multinational telecommunications company.

BCI, under the leadership of Derek Burney, continues to provide BCE with international telecommunications consulting and investment. In the United Kingdom, BCI maintains an operating interest in Bell Cablemedia plc, a provider of cable television and telecommunications services, and Mercury Communications Limited, a full-service telecommunications carrier with an estimated 14 percent share of the British Market and over two million lines installed. BCI also has continuing interest in four of the world's most promising, emerging markets, including cellular operations in Colombia and China, wireless and wireline operations in India, and a cable television network in Brazil

u contributed by Linda Stranahan

Burney, Derek H.

Derek H. Burney is the chairman, president, and chief executive officer of Bell Canada International Inc. (BCI), as well as executive vice-president, international, of BCIs parent company, Bell Canada Enterprises Inc. (BCE). BCI is the international investment arm of BCE and, as such, is responsible for seeking out and developing investments in international telecommunication markets. Mr. Burney has been with BCE since 1993, having spent the previous 30 years as a career foreign-service officer.

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Mr. Burney was born in Thunder Bay, Ontario and was educated at Queens University in Kingston, Ontario, where he received an honors B.A. and M.A. in political science. He began his career in foreign service in 1963, serving as an officer in the department of External Affairs, both in Canada and abroad. Early in his career, Mr. Burney embarked on a specialty in the Far East. On his first foreign assignment, he spent seven years in Japan. From 1978 to 1980 he served as ambassador to the Republic of Korea, then returned home to administer the economic summit in Quebec in 1981. From 1982 to 1983, he was involved with the Canada-US trade policy review, which led to his assignment as assistant deputy prime minister for United States Affairs from 1983 to 1985 and associate under secretary of state for External Affairs from 1985 to 1987.

In 1987, Mr. Burneys career took an unexpected turn when he was appointed as chief of staff to the Prime Minister. Mr. Burneys reputation as a strong leader brought him the assignment and was exactly what the Prime Ministers Office needed. Besides straightening out the PMO, he used his vast knowledge in trade negotiations and his belief in trade liberalization to complete successful US-Canada trade negotiations. With these successes came his appointment to the US ambassadorship in 1989.

Mr. Burney came to the job of ambassador to the United States as an expert on foreign trade and was instrumental in resolving problems that threatened to derail the Free Trade Agreement (FTA) with the United States before it was ever signed. He also brought a cautious, yet forceful presence to the position of ambassador and a down-to-earth demeanor that fit with the conservative administration of President George Bush.

While serving as ambassador to the United States, Mr. Burney was also the Prime Ministers personal representative in the preparations for the economic summits in Houston (1990), London (1991), and Munich (1992). In February 1992, Mr. Burney was awarded the Public Service of Canadas Outstanding Achievement Award. In July 1993, he was named an officer of the Order of Canada.

After completing his job as US ambassador, Mr. Burney was asked by the CEO of BCE, L.R. (Red) Wilson, to take a leadership role in BCEs international subsidiary, BCI. Mr. Burney agreed, and under his leadership BCI expanded its international telecommunications interests. In 1993, BCI entered into a partnership with Jones Intercable Inc., one of the largest cable television providers in the United States, to develop cable television/telephone service in Britain. In 1994, BCI bought a 30% interest in Jones, as a commitment to continuing development of cable television/telephone opportunities. BCI currently has telephone, cable television, and cellular interests throughout the world, including the Far East, Europe, and South America.

In addition to his duties at BCI, Mr. Burney is vice-chairman of Jones Intercable Inc. He is also a director of Bell Cablemedia plc, Moore Corporation Limited, Maritime Telegraph and Telephone Company Limited, Northbridge Programming Inc., and Teleglobe Inc.

u contributed by Linda Stranahan

Wilson, L.R. (Red)

L.R. (Red) Wilson is the Chairman, President, and Chief Executive Officer of Bell Canada Enterprises Inc. (BCE). BCE is the holding company for several telecommunications companies, most notable of which is Bell Canada, that provide telephone service to 70 percent of Canada's population, as well as providing mobile telephone service, the design and development of advanced telecommunications equipment, telephone directories, and national and international telecommunications consulting. Mr. Wilson came to BCE in 1990 and has been the president and chief executive officer since 1992 and chairman since 1993.

L.R. (Red) Wilson is the Chairman, President, and Chief Executive Officer of Bell Canada Enterprises Inc. (BCE). BCE is the holding company for several telecommunications companies, most notable of which is Bell Canada, that provide telephone service to 70 percent of Canada's population, as well as providing mobile telephone service, the design and development of advanced telecommunications equipment, telephone directories, and national and international telecommunications consulting. Mr. Wilson came to BCE in 1990 and has been the president and chief executive officer since 1992 and chairman since 1993.

Mr. Wilson received an honors B.A. from McMaster University and an M.A. from Cornell University. In addition, he has received an honorary D.h.c. degree from the Universite de Montreal and an honorary L.L.D. degree from McMaster University.

Prior to coming to BCE, Mr. Wilson served in several management positions, the most notable of which include:

- 1978 to 1981 Deputy Minister, Ministry of Industry and Tourism, Government of Ontario

- 1981 to 1988 President and Chief Executive Officer, Redpath Industries Limited, Toronto, Ontario

- 1986 to 1989 Managing Director, North America, Tate & Lyle PLC

- 1988 to 1989 Chairman of the Board, Redpath Industries Limited

- 1989 to 1990 Vice-Chairman, The Bank of Nova Scotia, Toronto, Ontario

When Mr. Wilson took over the leadership of BCE, he was faced with a number of problems stemming from the acquisition of several diversified companies by his predecessors. Many of the companies were losing money and putting a drain on BCE's resources. In a move to reestablish the company's financial health, Mr. Wilson disposed of the non-telecommunication related businesses and brought in leadership that could turn the remaining businesses around. By 1994, BCE's profits reached $1.2 billion, a turnaround of $1.8 billion from the deficit registered in 1993. Under Mr. Wilson's management, BCE has become a thriving multinational business, with investments in

American and British cable television systems, cellular telephone service in Columbia, and international sales of telecommunication equipment. As BCE moves into the future, Mr. Wilson is directing it down a path that emphasizes customer service, fiscal responsibility, a competitive spirit, and cutting-edge technology. BCE is expanding its fiber-optic network, mobile cellular telephone operation, and satellite broadcast and communications capabilities throughout Canada.

In addition to his duties as president and CEO of BCE, Mr. Wilson is a Director for Bell Canada International Inc. (BCI), BCE Mobile Communications Inc., Bell Canada, NORTEL (formerly Northern Telecom), Bell-Northern Research Ltd., Teleglobe Inc., Chrysler Canada Ltd., Chrysler Corporation, Tate & Lyle PLC (London), Stelco Inc., C.D. Howe Institute, and The Canadian Institute for Advanced Research. Mr. Wilson is also a member of the British-North American Committee, the Business Council on National Issues; the Trilateral Commission, and the International Council of J.P. Morgan & Co. He serves on the Board of Trustees for the Montreal Museum of Fine Arts Foundation and is a Governor for the Olympic Trust of Canada at McGill University.

u contributed by Linda Stranahan

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430 BC Optical Telegraph

In Greece, messages are relayed by an optical telegraph system; combinations of five torches are used to represent the letters of the Greek alphabet as signals are sent from hilltop to hilltop

100 BC Codex

The codex, a notebook made from leaves of parchment sewn together down one side, is in use in Rome

70 BC Shorthand

Marcus Tullius Tiron develops a version of shorthand that will be used for about 1,000 years; users include Julius Caesar and Cicero, among others

60 BC Roman Newspaper

Julius Caesar is said to have invented an early newspaper; newsworthy information is written on parchment and posted on the outside of central buildings

105 Paper Invented

Paper is invented in China by Cai Lun, who served in the court of He Di

500 Abacus

The abacus, a counting device, is first used in Europe; counting boards based on similar principles were used by Greeks and Romans as much as 1,000 years earlier

600 Wood Block Printing

Whole pages are printed by the Chinese using wood blocks; the earliest known surviving pages date from the eighth century

618 Chinese Newspaper

In China, publication of a court newspaper begins; several dozen copies are printed of each edition; this form of news reporting at the Chinese courts continues until 1911

646 Alexandria Library

What is probably the final destruction of the library at Alexandria takes place; the Muslim general Amr ibn-al-As performs this task under orders from his caliph

704-51 Printed Text

A Buddhist charm scroll is created using wood blocks to produce the images; this is the earliest known surviving example of printed text

The first newspaper printed in significant numbers appears in Beijing, China

800 Kana Developed

A phonetic script called kana is developed for writing Japanese; this script is simpler and easier to learn than the Chinese ideograms previously used, and both women and men become literate; some of the great works in the Japanese language are written by women in the next two centuries, including *Tale of Genji*, by Lady Murasaki

The Diamond Sutra is printed on May 11 by Wang Jye; the scroll is the earliest complete printed document in existence; it consists of seven large sheets (one featuring a woodcut picture) that have been pasted together end-to-end to make the continuous scroll; it is discovered in Kansu by Aurel Stein in 1900

876 Zero

Although the concept may have originated earlier, this year sees the first known reference to the symbol for zero used in an inscription in India

1000 Camera Obscura

Alhazen, born in Iraq but working in Egypt, writes a description but does not build the camera obscura; the camera works by projecting a real image into a darkened box and then viewing the image either by looking into the box or by projecting the image onto a ground glass lens to be seen from outside; after translation of Alhazen’s optical works into Latin as *Optisce thesaurus* in 1572, his writings become influential in the development and understanding of photographic methods

1000 Arabic Numerals

Pope Silvester II (Gerbert) implements the use among Christians of Arabic numerals, including zero

1041-48 Movable Type Invented

Movable type is invented in China by Bi-Sheng, a commoner; since China has no alphabet, he creates a rhyme scheme and stores the baked pottery characters according to their phonetic pronunciation; for printing, the pieces of type are set on a bed of resin inside a wooden frame and held in place by slices of bamboo

1050’s Movable Type Used

Movable type is used to print some Chinese books

1100’s Woodcut Printing

Europeans use woodcuts for block printing of capital letters

1107 Multi-color Printing

In an effort to make paper money more difficult to counterfeit, the Chinese develop multi-color printing

1290’s Woodcut Printing

Woodcuts are used for printing entire pages in Europe

1313 *Treatise of Agriculture*

Wang Chen has over 60,000 Chinese characters on printing blocks made from hard wood; using these, he develops new printing techniques and prints his *Treatise of Agriculture*

1379 Cryptography

Gabriel da Lavinda writes a manual on cryptography

1396 Movable Type

Working independently of the Chinese, Johannes Gutenberg and Laurens Janszoon Koster invent printing using movable type in Germany; however, the Chinese developments of using paper and printing with blocks were necessary in order for Gutenberg and Koster to be successful in printing with movable type

1396 Metal Type

Johannes Gutenberg, working in Germany, develops a method of casting metal type and creates an ink that adheres to the cast metal type for printing

1396 First Printed Book

Laurens Janszoon Koster prints *Speculum nostrae salutus* (Mirror of Our Salvation) in Germany; it is probably the first printed book

1452 Gutenberg Bible

Johannes Gutenberg begins setting type at Mainz, Germany, for the printing of the 42-line Bible; printing is completed in 1456

1457 Schoeffer’s Psalter

Peter Schoeffer uses letters that incorporate both blue and red inks to print his Psalter; his printing technique is unknown until 1830, when William Congreve discovers that Schoeffer’s letters consisted of two pieces that are inked separately and then fitted together

1460’s Single-pass Printing

Albert Pfister combines movable type with woodcuts on a single page, and prints both the images and text in only one pass of the press

1482 Geometric Figure Printing

Erhard Ratold publishes Euclid’s *Elements*, creating the first printed book illustrated with geometric figures

1500 Books Widespread

By this year, approximately 20 million copies of 35,000 different books have been printed; 77% of the books are in Latin, and 45% contain religious subject matter

1550 Cardano Camera Lens

Girolamo Cardano creates a camera lens in Italy

1553 Camera Obscura

Giambattista della Porta receives credit for inventing the camera obscura in Naples, Italy, although earlier works make clear reference to the device

1560’s Silver Salts

It is recognized that silver salts will turn black, but it is not yet known that exposure to light causes this change; only after this association is made will silver salts be used to coat photographic film

1588 Shorthand Modified

Englishman Timothy Bright modifies the shorthand developed in 70 BC by Marcus Tullius Tiron to an English language version

1590’s British Newspaper

A London publisher begins producing the *Mercurius gallo-belgicus*, the first British newspaper; it is printed until 1610 and provides news from the European continent

1600's European Newspaper

The first newspaper on the European continent is begun by Abraham Verhoeven in Antwerp, Belgium; it is called *Nieuwe Tijdingen*

1623 Encryption

Francis Bacon, the English writer and statesman, invents a code that will later receive widespread use; it consists of two letters and a combination of five characters, allowing the letters of the alphabet to be represented; this code is a successful attempt at early encryption

1638 American Printing Press

The first printing press on the North American continent is installed by Stephen Day at Cambridge, Massachusetts

1666 Leibniz Theories

Gottfried Wilhelm Leibniz of Germany writes his *Disserto de arte combinatoria*, in which he presents his theory that a mathematical language of reasoning can be developed; his work is based on the work of Raymond Lully; in the 19th century this theory will be further explored by George Boole and others, and Boolean mathematics will later be applied to computer science and artificial intelligence research

1694 Leibniz Computer

Gottfried Wilhelm Leibniz of Germany, an inventor of calculus, perfects a machine that multiplies by performing repetitive additions; the machine is called the Leibniz Computer, and the repetitive addition algorithm is still used in modern computers

1702 Daily Newspaper

The *Daily Courant*, printed in England, is considered the world’s first daily newspaper

1704 English Encyclopedia

John Harris, a London clergyman, publishes the first alphabetical encyclopedia in English, the *Lexicon Technicum, or an* [sic] *Universal English Dictionary of the Arts and Sciences;* it is produced in a single volume and is followed by a second volume in 1710

1709 Copyright Act

England’s Copyright Act is the first of its kind; it protects authors for 21 years and guarantees the writer an income directly proportional to the sales of a book

1710 Three-color Printing

Three-color printing is developed by Jacob Christoph Le Blon

1714 First Typewriter

Henry Mill, a London engineer, patents the first known typewriter; Mill claimed in his patent that his device could type letters so neat and exact as not to be distinguished from print; it is unknown today how the typewriter worked or whether it was even functional

1719 Four-color Printing

A four-color printing system is patented by Jacob Christoph Le Blon; it is based on creating secondary colors from primary colors by layering the single-color images obtained from plates inked in blue, yellow, red, and black until the desired secondary color is produced

1725 Stereotype

William Ged, a Scottish goldsmith, improves stereotype, a printing technique developed during the 15th century; printing is done from metal plates that are molded over rows of type; the plates retain the type images and can then be used for multiple reprints

1727 Silver Salts

Johann H. Schulze discovers exposure to light causes silver salts to turn black; this realization allows the salts to be used later for retaining images on photographic film

1739 Stereotype

William Ged, a Scottish goldsmith, further improves stereotype printing; pages are printed from plates of lead, obtained by pouring lead in a papier maché mold of the typeset; the method does not see widespread use until the 1790's

1748 Electricity Seen

William Watson observes what he terms rays of electricity in a tube in London

1751 Electrical Charges

American statesman, writer, and inventor Benjamin Franklin writes *Experiments and Observations on Electricity*, in which he describes electricity as a single fluid and makes the distinction between positive and negative electrical charges

1753 Telegraph

Scottish inventor Charles Morrison proposes in *Scots Magazine* that a telegraph be built from 26 electrical lines, each representing a letter of the alphabet

1774 Telegraph

Working in Switzerland, George Louis Lesage builds an electric telegraph with 26 electrical wires, one for each letter of the English alphabet; he follows the design of Scottish inventor Charles Morrison

1780 Mimeograph

James Watt invents a form of copying in which a special ink is used for making an original that can then be transferred to another sheet of paper; before the introduction of dry copying, variations of this mimeographic method using a purple dye were frequently used in schools

1792 Optical Semaphore

The French legislature officially adopts a relay system for long-distance communication using visual signals; this system, called the optical semaphore signaling system, was developed by brothers Claude and Ignace Chappe to send each other messages while at school

1793 Optical Semaphore

The first official optical semaphore telegram using visual signals is sent via Claude and Ignace Chappe's network of relay stations in France on August 15; it announces the French victory in the war with Austria; Chappe coins the term telegraph to describe his method of transmitting messages

1793 Stereotype Pressed Plates

Between 1793 and 1797, Louis-Etienne Herhan, Firmin Gillot, and Nicolas-Marie Gatteaux develop a method in France for creating the pressed plates used in stereotype printing

1796 Telegraph

Francisco Salva builds an electric telegraph system between Madrid and Aranjuez, Spain, a distance of 30 miles (50 kilometer); the connection is made of 44 wires that allow 22 characters to be transmitted in either direction; electrostatic machines generate the signals, which are detected as movements in the wires by people at either end of the system; Salva later uses sparks to indicate signals

1798 Lithography

Czech-born Aloys Senefelder invents lithography while working in Germany; not having any paper available, he writes a note with wax-based ink on a stone tablet; this inspires his idea to treat the stone printing plate with acid, which causes the surface protected by the ink to stand out in relief and allows it to be used for block printing

1800 Iron Printing Press

Lord Stanhope designs and builds a printing press made of iron rather than wood and begins using the press in London

1802 Silver Nitrate Images

In an announcement to the British Royal Institution, Thomas Wedgwood reveals that he has found a method for creating images on silver nitrate using a camera obscura

1806 Automatic Numbering

Joseph Bramah invents a printing machine that automatically numbers bank notes as it prints them

1807 Camera Lucida

The camera lucida is invented by William Hyde Wollastone in England; images of drawings are produced on another sheet of paper, allowing them to be copied, enlarged, or reduced by tracing the original image

1808 Color Lithography

The first color lithographs are produced in Munich by Strixner and Piloty; smooth printing plates (usually made of stone or metal) are treated so that the area to be printed is receptive to the application of ink, while the area that does not contain an image will repel ink

1809 Telegraph

Samuel Soemmering builds a multiwire telegraph in Germany

1810 Silver Chloride Exposure

Thomas Seebeck of Germany writes to Johann Wolfgang von Goethe that silver chloride, when exposed to light of a particular color, has a tendency to take on the color of that light

1811 Mechanical Printing Press

The first mechanical press is built in London by Frederic Koenig; it can print 3,000 sheets per hour

1812 Underwater Telegraph

German inventor Samuel Soemmering builds an underwater telegraph that uses electrolysis to detect signals that are transmitted electrically; the telegraph works through 25 wires that end in a tank full of water; each wire is assigned a letter, and by watching for air bubbles coming from the wires the user can detect which letters have been transmitted

1814 Steam-driven Printing Press

The Times of London is printed on a steam-driven cylinder press capable of printing 1,000 sheets per hour

1816 Photographic Experiments

French inventor Joseph Nicephore Niepce begins conducting experiments which lead to the development of early photographs

1818 Lithography

Aloys Senefelder, born in the Czech Republic but working in Germany, modifies his method of lithography to produce color printing

1822 Permanent Photography

The first permanent photograph is created by Joseph Nicephore Niepce and Claude Niepce in France

1822 Typesetting

A typesetting machine is invented by William Church of New York

1822 Difference Engine

Charles Babbage of England designs his Difference Engine to calculate logarithms but never builds the machine

1823 Acid Etching

In France, Firmin Gillot uses acid etching to produce copper printing plates from photographs; this method of creating images is essentially a lithographic process

1825 Traumatrope

John Ayrton develops the traumatrope, a device that produces moving images through persistence of vision; the viewer sees still images being moved so quickly that the mind believes the pictures are of moving objects

1829 Typewriter

A workable typewriter, the Typographer, is patented by American inventor William Austin Burt; the typist rotates an arm to the desired letter and presses down, inking the letter on an ink pad before typing the letter on paper

1831 Electromagnetic Telegraph

Joseph Henry of Albany, New York, builds the first electromagnetic telegraph line; an electric charge travels through 5,000 feet (1,500 meters) of wire, where an electromagnet forces a suspended magnet to swivel and ring a bell

1832 Phenakistoscope

Joseph Plateau of Belgium develops the phenakistoscope after studying the retinal retention of the eye; two disks are mounted on a single axis, one carrying several images of an object or person in motion; these pictures are observed through slits in the other disk; the illusion of motion is created by rotating the disk with the images and observing the movement through the slits

1832 Stereoscope

Charles Wheatstone of England invents the stereoscope, a device designed to allow the user to view two similar pictures simultaneously, with each image being seen by only one eye; the two pictures are taken at slightly different angles, but the human brain combines them into an image that appears three-dimensional when viewed through the stereoscope; this principle is behind the View-Master children's toy and has also been used in applications in topography and motion analysis

1832 Analytical Engine

Charles Babbage of England begins developing the Analytical Engine, the world's first computer; it can be programmed to solve a wide variety of logical and computational problems; when Babbage dies, he leaves more than 400 square feet of drawings and designs for the device

1833 Photographic Experiments

In October, William Henry Fox Talbot of England conceives of photography while experimenting with the camera obscura

1833 Electric Telegraph

Karl Friedrich Gauss and Wilhelm Weber design and build an electric telegraph that operates over a distance of 1.25 miles (2 kilometer) in Germany; a mirror galvanometer acts as the receiver

1833 Typewriter

Xavier Progin builds the first typewriter with a manual keyboard; each letter is mounted on a separate hammer and inked by an ink pad

1834 Photographic Experiments

William Henry Fox Talbot of England begins experiments with silver nitrate and exposure to light that eventually lead to the development of photography

1834 Zoetrope

William George Horner improves Plateau's phenakistoscope, naming his motion picture device the zoetrope

1835 Photography

William Henry Fox Talbot takes experimental pictures of his home at Lacock Abbey using his new invention, photography

1835 First Press Agency

Charles Havas founds the first press agency in the world, although several years will pass before he implements use of the telegraph to report international news

1835 Telegraphic Principles

Joseph Henry of Albany, New York develops the basic principles of what becomes the standard telegraph in America; these ideas include the electrical relay and the use of the Earth as a grounding device; the electrical relay is a method of transmitting electrical signals over long distances

1836 Electrical Relay Telegraph

Working independently of Joseph Henry, Edward Davy of England discovers the electrical relay and applies it to the telegraph

1837 Five-needle Telegraph

The first electric telegraph in England, using six wires and five needles, is patented by Charles Wheatstone and William Fothergill Cooke; called a five-needle telegraph, it uses needles to point to letters of the alphabet; Wheatstone and Cooke found the Electric Telegraph Company

1837 Morse Telegraph

Samuel Finley Breese Morse, an American, sees an electromagnet demonstrated while he is taking a transatlantic trip; the demonstration inspires his idea to use an electromagnet for transmitting telegraph signals

1837 Single-wire Telegraph

Karl August Steinheil rediscovers that the earth can conduct electric currents, allowing him to invent a telegraph system using only one wire; Steinheil’s telegraph system is the first to print characters on a paper ribbon

1838 Daguerreotypes

Frenchman Louis-Jacques Daguerre announces his method for making silver images on copper plates; these images, called daguerreotypes, are popular before photographs become common; sheets of copper are coated with a layer of silver and then treated with heated iodine crystals; the silver plating becomes sensitive to light, but the plates must be exposed for several minutes in order to retain a picture

1839 Commercial Telegraph

The first commercial telegraph line, operated by the Electric Telegraph Company, starts operation in Great Britain; the line links Liverpool with Manchester

1839 Photographic Experiments

Sir John Herschel of England demonstrates a new method for slowing down the darkening of silver salts exposed to light; William Henry Fox Talbot used sodium chloride (table salt) in the developing process to slow down the film's reaction time and increase the photographer's control over film sensitivity; Herschel shows that by substituting sodium thiosulphate (known as hypo, short for sodium hyposulfite, an older name for the compound), the reaction time is further decreased, allowing greater control of the lightness and darkness of photographs

1840 Oldest Surviving Photograph

Englishman John William Draper, working in New York, takes what is now known as the oldest surviving photograph of a person

1840 Morse/Vail Telegraph Patent

Samuel Morse and Alfred Vail patent their electromagnetic message relay system in America

1843 Ada Lovelace's *Notes*

Notes, written by Ada Lovelace, also known as Lady Byron, to relate her experience with Charles Babbage's Analytical Engine, are published

1843 Typewriter

Charles Thurber of Worcester, Massachusetts, patents a form of typewriter in which pressing directly on a letter mounted on a wheel causes the letter to strike a piece of paper

1844 Morse Telegraph Line

The first morse telegraph line opens between Baltimore and Washington, D. C., carrying the message What hath God wrought?

1844 Zinc-plate Printing

Werner von Siemens of Germany develops a method of copying in which the image to be reproduced is raised into relief and then printed using zinc plates

1845 Underwater Telegraph

The first underwater telegraph cable is laid between New York City and Fort Lee, New Jersey; it passes under the Hudson River

1845 Telegraph Arrest

Englishman Charles Wheatstone’s telegraph is used in the arrest of the Quaker Murderer; the suspect is seen riding a train bound for London, a telegram is sent to the authorities from the Slough train station and the man is arrested when he arrives at Paddington Station

1846 Printing Telegraph

Royal House, an American inventor, develops the printing telegraph

1846 Photogrammetry

Amie Laussedat develops a method for measuring buildings and structures using photographs taken from two different angles; it is called photogrammetry

1846 Punched-paper Telegraph Messages

Alexander Bain of Scotland sends telegraph messages using punched paper tape, making message transmission much faster

1846 Electric Telegraph

Samuel Morse uses Joseph Henry’s designs for an electrical relay telegraph to construct a practical electric telegraph system in America

1847 Gutta-percha Insulation

Werner von Siemens suggests that gutta-percha be used to preserve electrical wiring from moisture, an idea that leads to the first underground and submarine telegraph cables

1847 TV and Fax Precursor

Frederik Bakewell invents an early precursor to television and facsimile machines; his device transmits a picture painted with shellac on one roller to another roller; synchronization of the roller drums at each end is a problem that stands in the way of broad commercialization, although Bakewell obtains a patent for the machine in 1848

1847 Printing Presses

Richard March Hoe invents the rotary and web printing presses; his rotary presses print a maximum of 18,000 sheets per hour, printing on both sides of the paper; the rotary press allows large circulation newspapers to reach a wide audience; the first newspaper to use Hoe’s rotary press is the *Philadelphia Public Ledger*

1847 Albuminized Glass Plate Photography

The albuminized glass plate is introduced to photography by Abel Niepce de Saint-Victor in France

1847 Stereoscope

Sir David Brewster of England improves the stereoscope as a device for simultaneously viewing two photographs taken from slightly different angles; the brain combines the two images into one and creates the illusion that the viewer is seeing a three-dimensional picture

1848 Associated Press

In order to share the costs of telegraphy, six newspapers in New York City found the Associated Press

1849 Reuter

Paul Julius, Baron von Reuter founds a predecessor of the Reuter press agency for the purpose of carrying stock prices between Brussels, Belgium and Aachen, Germany; it is initially a homing pigeon service

1850 Submerged Telegraph

The firm of Siemens and Halske lays the first submerged telegraph line; it runs between Dover, England, and Calais, France, but the anchor of a French fishing boat cuts the cable; a replacement cable is laid a year later

1850 Inked-ribbon Typewriter

Oliver T. Eddy of Baltimore, Maryland, patents the first typewriter to use an inked ribbon instead of a pad or roller to supply the ink; a piano keyboard is used to input the letters

1850 Typewriter Paper-feed

The first typewriter to use a continuous-roll paper feed is patented by John B. Fairbank

1851 Collodion Wet Plate

The collodion wet plate process is introduced to photography by Frederick Scott Archer; collodion pictures feature a high degree of sharpness accompanied by short exposure times and easy reproduction; however, the technique requires that the photographs be developed within a short time after the plate is exposed to light, or the image will be lost; because of this time limitation, portable darkrooms have to be moved to the site where photographs are being taken

1851 Reuter

Paul Julius, Baron von Reuter opens a telegraphic service in London

1853 Pneumatic System

Josiah Latimer Clark designs and builds a pneumatic system in London for sending telegraphs between the Stock Exchange and the International Telegraph Company; a tube 720 feet (220 meters) long carries documents in cylinders that are sucked from one location to the other

1853 Type Revolving Press

American inventor Richard March Hoe builds the Type Revolving Press, capable of printing 20,000 sheets each hour

1854 Boolean Algebra

British mathematician George Boole publishes *An Investigation of the Laws of Thought, On Which Are Founded the Mathematical Theories of Logic and Probabilities*, in which he develops his theories on symbolic logic; these theories, collectively known as Boolean algebra, form the foundation for numerous applications in computer science and artificial intelligence research in the mid-20th century

1854 Polychromatic Printing Press

Georg Herman Babcock of New York, working with his father, designs and builds the polychromatic printing press; it is capable of printing several ink colors simultaneously

1854 Telegraph Widespread

The total length of telegraph lines in the world exceeds 23,000 miles (37,000 kilometers); in the U.S., this network covers 15,500 miles (25,000 kilometers)

1855 Electric Writing Machine

In London, Giuseppe Devincenzi files a patent for the earliest known electric writing machine, nearly 50 years before a successful electric typewriter will be invented

1855 Collotype

Alphonse Poitevin of France invents the collotype photographic printing process; the method accurately reproduces photographs, but it is complicated and poorly suited for anything but the shortest of print runs

1855 Underwater Electrical Transmission

Englishman William Thomson, also known as Lord Kelvin, finds a way to transmit electrical signals through cables under water; the method is used in the first submarine telegraph lines

1855 Mercury Pump

Heinrich Geissler Igelshieb builds a mercury pump, later used to build usable vacuum tubes; the tubes lead to the development of cathode rays and the discovery of electrons

1856 Phono-autograph

Léon Scott de Martinville invents the phono-autograph, a predecessor of the phonograph; the instrument traces a line representing sound vibrations on a rotating drum; the device is used to research methods of recording and playing sound

1857 Transatlantic Telegraph

A transatlantic telegraph line is laid, but breaks 6,000 feet (1,800 meters) below the ocean's surface only three months later; the cable cannot be recovered

1858 Color Photographic Printing

French inventor Louis Ducos du Hauron patents a form of color printing using photographs printed on zinc plates through color filters

1858 Pneumatic System

Cromwell F. Varley of England improves the way telegrams are sent between the Stock Exchange and the International Telegraph Company in London; compressed air and suction are used to push and pull documents through the pneumatic tube system, allowing materials to travel in two directions

1858 Morse Telegraph

Charles Wheatstone develops a high speed automatic morse telegraph system in England

1858 Reuter

Paul Julius, Baron von Reuter’s London telegraph agency becomes a press agency

1859 Pneumatic System

R. S. Culley and R. Sabine, working in London, introduce a radial pneumatic mail system for use by the British post office; the system is similar to the way messages are conveyed between the Stock Exchange and the International Telegraph Company, as it carries telegrams from a central location out to branch offices via a network of tubes

1859 Microdot Photography

John Benjamin Dancer demonstrates microdot photography after successfully photographing whole pages of books onto slides only 1/1,600 of an inch on each side

1860 Biconvex Camera Lens

C. C. Harrison and J. Schnitzler design the biconvex photographic lens, in which an image is seen through two convex lenses so that distortion is reduced

1861 Transcontinental Telegraph

A telegraph line is established between San Francisco and New York, contributing to the closing of the Pony Express

1861 Color Photograph Projection

Scottish inventor James Clerk Maxwell, working with photographer T. Sutton, demonstrates the first projected color reproduction of a photograph; he projects three pictures of the Scottish flag, one each taken through red, green, and violet filters; he then aligns the images to create a single picture, using light of the same three colors to illuminate the color image

1861 Music Transmission

Philipp Reis, a German schoolteacher, sends music over a distance of 300 feet (100 meters) with an invention he calls a telephone; Reis later takes credit for inventing the telephone, but Alexander Graham Bell's device works on a different principle and transmits speech

1863 Pantelegraph

French physicist Giovanni Caselli, working in the United States, patents his pantelegraph, a machine designed to transmit facsimile reproductions; the apparatus uses two synchronized pendulums with attached metallic pointers suspended below; the message is written on a metal plate, moving one pendulum with the hand that is writing; the corresponding pendulum picks up these vibrations and transmits a copy of what the sender writes

1864 Electromagnetic Waves

Scottish inventor James Clerk Maxwell theorizes the existence of electromagnetic waves

1864 Silver Bromide Emulsion

Silver bromide emulsion is introduced to photography by B. J. Sayce and W. B. Bolton

1865 Rotary Printing Press

American inventor William Bullock designs and builds a rotary press that prints from a roll of paper, which proves useful in printing newspapers

1865 International Telegraph Union

Twenty countries agree to work together to send telegraph messages, creating the forerunner of the International Telegraph Union (ITU)

1866 Transatlantic Telegraph

Cyrus West Field, an American, lays the first successful transatlantic telegraph lines

1866 Wireless Telegraph

Working between two mountains in West Virginia, Mahlon Loomis transmits telegraph messages over radio waves using receivers held in the air by kites

1866 Acoustic Research

Alexander Graham Bell begins working on the incorrect premise that sound travels via electric wires; this assumption sets back his acoustic research

1867 Typewriter

Christopher Sholes, Carlos Glidden, and Samuel W. Soule design what will eventually become the first successful typewriter, the Remington Model 1; their machine is patented a year later

1869 *Colors in Photography*

French inventor Louis Ducos de Hauron describes a method he has created for recording a color image on a photographic plate and then projecting it using only one projector in *Les Colours en photographie, solution du probleme (Colors in Photography, the Solution to the Problem)*; his method involves breaking up the colors of light from the projector into tiny dots that show up as separate dots of color on the screen, which are then combined by the eye to appear as a single color; he also observes and states the additive and subtractive ways that different colors can be obtained from the primary colors of light

1869 Color Photography

Charles Cros discovers the additive and subtractive principle used in color photography while working independently of his countryman, Louis Ducos de Hauron

1871 Dry-plate Photography

Richard L. Maddox introduces the dry plate photographic process using bromide on gelatin-coated plates

1872 Time-division Multiplexer

Jean-Maurice-Emile Baudot of France develops the time-division multiplexer printing telegraph system

1872 Electric Typewriter

Thomas Alva Edison patents an electric typewriter that is very similar to the teletype machines later used by press agencies

1872 QWERTY Keyboard

Latham Sholes develops an improved form of typewriter that will be manufactured by Philo Remington of Ilion, New York; this typewriter is the first to use the qwerty keyboard, referring to the order of keys in the top row, that arrangement is now standard

1872 Photogravure

Charles Gillot applies the Poitevin collotype process to standard printing, inventing a form of photogravure

1872 Western Electric Company

Elisha Gray of Barnesville, Ohio, founds the Western Electric Manufacturing Company, later called the Western Electric Company, a pioneer in communications

1872 Submerged Telegraph

England and Australia are linked via submerged telegraph cables

1873 Color Photography

Hermann Vogel treats collodion plates used in photography with aniline dye, thereby improving their sensitivity to green light; he later improves the sensitivity of photographic plates to other colors, allowing better color reproduction

1874 Quadruplex Telegraph

Thomas Edison develops the perfected quadruplex telegraph, capable of simultaneously transmitting two messages going separate directions over one telegraph line or four messages going the same direction; this invention secures Edison’s early reputation as an inventor

1874 Binary Code

Jean-Maurice-Emile Baudot of France develops a binary code using five bits to represent characters; this code is used internationally until 1930

1874 Harmonic Telegraph

In a failed attempt to develop the telephone, Alexander Graham Bell patents a harmonic telegraph that simultaneously transmits two or more musical tones; it is similar to a more complex multiple sound telegraph developed by Elisha Gray

1875 Sound Transmission

Alexander Graham Bell successfully transmits sounds over electric lines

1875 Heliogravure

Austrian printer Karl Klietsch develops heliogravure, a photographic process for etching an image on a metal plate; the image can then be used for printing reproductions

1875 Television Precursor

George R. Carey designs a system in which an image is transmitted by several light-sensitive selenium cells that switch a bank of electric lights on or off as an object moves in front of the cells; this system, if built, would have been an early form of television

1876 Telephone Patent

Elisha Gray files a notice with the patent office for an invention that transmits voice and sound on February 14, only two hours after Alexander Graham Bell applies for a patent on his own version of the telephone; many experts believe that Gray's device would have worked better than Bell's telephone; the U.S. courts declare Bell the inventor after many years of litigation; the microphone and receiver of the telephone are identical, having a magnet surrounded by solenoid placed near an iron membrane; the vibrating membrane produces currents in the solenoid cell, causing the membrane in the receiving telephone to vibrate and thus transmit words; the first words, Mr. Watson, come here, I want you, are inadvertently transmitted by Bell to his assistant Thomas A. Watson in an adjoining room

1877 Phono-autograph

Working independently of Thomas Edison, Charles Cros of France proposes that Leon Scott de Martinville's phono-autograph system be used to reproduce sound; Cros does not build such a device, but his idea precedes the system developed by Edison, giving the French a legitimate claim to the invention of the phonograph

1877 Phonograph

Using a sketch made by Thomas Edison, a workman named John Kruesi builds the first phonograph between November 29 and December 6; a needle traces a groove on tin foil wrapped around a rotating cylinder, and the same needle replays the recording; Edison recites Mary had a little lamb in the first recording; after some minor adjustments, Edison goes to the offices of *Scientific American* on December 7, where he prepares a patent application and demonstrates his invention; he files his patent application on December 15, and the December 22 issue of the magazine unveils the device

1877 Microphone

Emile Berliner of Germany patents the microphone

1878 Commercial Telephone Exchange

The first commercial telephone exchange opens at New Haven, Connecticut, on January 28

1878 Typewriter

The Remington No. 2 typewriter contains the first shift bar, allowing the user to type both lower and upper case letters from the same keyboard

1878 Cathode Ray Tube

While addressing the Royal Society on November 30, William Crookes of England describes his work in passing electric discharges through an evacuated glass tube; this is an early form of the cathode ray tube

1879 Photographic Dry Plates

American photographer and inventor George Eastman patents a photographic emulsion coating machine and begins mass-producing photographic dry plates

1879 British Telephone Exchange

Bell Telephone opens its first exchange in London on Coleman Street; in the same month, Thomas Edison forms the Edison Telephone Company Ltd., promptly opening exchanges on London’s Lombard and Queen Victoria Streets

1880 Screen Photograph

On March 4, *The New York Daily Graphic* is the first publication to use a screen photograph; the picture is seen as a screen of tiny dots, and darker areas are shown with a higher density of dots

1880 Photophone

Alexander Graham Bell patents the photophone, a device that transmits sound via light; the motion of sound in a telephone circuit vibrates a mirror that reflects sunlight to a selenium detector

1881 Two-wire Telephone

Telephones that use two wires and circuits made entirely of metal are introduced

1882 Dachshund Telephone

Lars Magnus Ericsson introduces a telephone nicknamed the dachshund because the handset, containing both the microphone and the earpiece, rests on a cradle shaped like a small dog

1883 Electromagnetic Waves

George Francis Fitzgerald of Ireland demonstrates that Scottish inventor James Clerk Maxwell's theory of electromagnetic waves indicates that the regular variation of an electric current will produce such waves; radio waves are still generated in this manner

1883 Edison Effect

Thomas Edison discovers what we know as the Edison effect; by placing a metal plate in an empty incandescent lamp, he discovers that there is a current between the filament and another electrode; this is the basic principle of the operation of the vacuum tube, but Edison loses interest in this discovery when he fails to see any immediate scientific applications

1883 Electric Transformer

Working together, Lucien Gaulard of France and John Dixon Gibbs of England develop an induction coil system for use as an electric transformer; the coils are arranged in a series circuit, although it is later seen that this is an inefficient approach

1884 Television Precursor

Paul Nipkow patents a precursor to the television system using a rotating disk called a mechanical sequential scanning disk; a narrow beam of light from an object passes through a hole in the disk, and the intensity of the light is measured by a selenium photocell

1884 Typesetting

Ottmar Mergenthaler, a German working in the United States, designs the Linotype typesetting machine; the machine includes a typewriter keyboard and produces entire lines of type called slugs

1884 Rolled Paper Film

Americans George Eastman and William H. Walker develop rolls of film for use in photography but are unable to produce large quantities of rolled film; the photo negatives must still be mounted on glass before prints can be made

1884 Telephone

Boston and New York City are connected by telephone wires

1885 Gramophone

Alexander Graham Bell and Charles Tainter demonstrate the gramophone

1885 Screen Photograph

Frederic E. Ives of Philadelphia, Pennsylvania, improves his halftone method of printing screen photographs; the new procedure is greatly simplified, and the method is still used today

1885 Rolled Paper Film

American photographer and inventor George Eastman patents a machine that produces a continuous roll of photographic film

1885 Electric Transformer

William Stanley of Brooklyn, New York, improves the electric transformer designed by Lucien Gaulard and John Dixon Gibbs in 1883 by replacing the iron wires with rings and plates and modifying the device to use a parallel rather than series construction

1886 Wax-disc Recording

Alexander Graham Bell uses wax discs for recording sound from a modified version of Thomas Edison’s phonograph

1886 Coaxial Cables

R. S. Waring uses coaxial cables for telephone lines, reducing static interference caused by electric power lines

1887 Gramophone Records

The first black shellac-based gramophone records are made

1887 Multiplexing

Western Union introduces multiplexing to telephone lines; while utilizing only one telephone line, very low frequencies transmit telegraphic signals and higher frequencies transmit voice signals

1887 Monotype Typesetting

The Monotype typesetting machine is patented by Tolbert Lanston

1887 Photoemissive Effect

Heinrich Hertz of Germany proves James Clerk Maxwell's theories as he demonstrates the presence of electromagnetic radio waves through a series of laboratory experiments; Hertz also discovers the photoemissive effect when he observes that exposure to ultraviolet light can change the length of an electron spark emitted from a piece of metal struck by light

1888 Flat-disk Phonograph

Emile Berliner of Germany invents a flat disk phonograph, eliminating the cylinder system invented by Thomas Edison; the system is called the gramophone; it quickly becomes popular with the record industry

1888 Kinetoscope

Thomas Edison and William Dickson design, build, and patent a motion picture device with synchronized audio; a cylinder with a series of photographs on it is controlled by Edison's phonograph, allowing the audio and video to play in unison; the photographs are inside a box and are seen through a magnifying lens; the viewer's brain tricks the eyes into believing that the pictures are in motion; the device is called a Kinetoscope

1888 Kodak

The first commercial camera using paper rolls of film (rather than plates) is introduced by American photographer and inventor George Eastman; he calls this invention the Kodak; at $25, this is an expensive device and a luxury item; each box camera takes 100 pictures, and the entire camera with film inside must be returned to the manufacturer for processing

1888 Photoemissive Effect

Wilhelm Hallwach of Germany confirms the photoemissive effect discovered by his countryman Heinrich Hertz; when zinc is hit by rays of ultraviolet light, the metal releases negative electricity

1888 Alternating Currents

Oliver Schallenberger invents an electric meter that measures variations in alternating currents

1888 Television Photocell

The first photocell is developed; later, it will be of great importance to the development of television

1889 Telegraphone

Valdemar Poulsen of Denmark patents the process he develops for making magnetic sound recordings with the telegraphone; such recordings are predecessors of cassette and video tapes, which are also magnetic in nature

1889 Motion Picture Camera

William Friese-Greene of Great Britain patents a motion picture camera; it takes ten photographs per second on paper roll film; scenes filmed at Hyde Park Corner in London are the first cinematic pictures to be projected (Edison's Kinetoscope did not involve projection of images)

1889 Rolled Celluloid Film

American photographer and inventor George Eastman creates a transparent version of roll film that is easier to use than his paper roll film; this change opens the way for popular photography using celluloid roll film in cameras

1890 Coherer

Frenchman Edouard Branly invents the coherer, a device designed to detect the presence of electromagnetism; the coherer is a small glass tube filled with iron filings that normally have a very strong magnetic resistance to each other; in the presence of electromagnetic radiation, that resistance decreases drastically

1890 Computer Precursor

Herman Hollerith of Buffalo, New York, patents an electromechanical information machine, or early computer, that uses punched cards for data processing; Hollerith incorporates ideas from Jacquard’s loom and Babbage’s Analytical Engine in his design; the machine is the first to use electricity in a major data processing project when it performs the calculations for the 1890 U.S. Census; the machine is also used for census-taking in 1895 by the Russians and in 1900 by the Austrians

1891 Celluloid Motion Picture

Thomas Edison finds a way to take motion pictures using George Eastman's celluloid film on the Kinetoscope; his patent application is intended to replace the patent description of the cylindrical Kinetoscope filed with the Patent Office in 1888, but he fails to suggest projecting the motion picture; instead, the strip of film is still designed to be seen through a magnifying glass as the pictures are wound from one reel to another inside a box

1891 Color Photography

Gabriel Jonas Lippmann, a French physicist, presents a paper to the French Academy of Science that contains a description of his color photography method, which involves using a thick emulsion over a reflective mercury surface to capture incidental waves of light; the colors can only be seen at a right angle, and the technique does not become popular

1892 Automatic Telephone Switching

Almon B. Strowger, an American undertaker, invents the first practical automatic telephone switching system; the caller is able to determine who the receiver of the phone call will be without using a human operator; according to legend, Strowger is motivated to create this system because his chief business rival's wife is the telephone switchboard operator, and she begins to misdirect calls meant for Strowger to her husband; Strowger's invention helps lead to the dial telephone

1892 Automated Telephone Exchange

The first public automated telephone exchange is installed in La Porte, Indiana

1892 Telephone Service

Telephone service links New York City and Chicago, which are 900 miles (1,500 kilometers) apart

1892 Typewriter

Thomas Oliver patents and produces the first practical and functional typewriter that allows the typist to see the words as they are being typed

1893 Telegraphone

Valdemar Poulson of Denmark builds the telegraphone, the earliest known magnetic sound recorder; a steel wire is wrapped around a cylinder, and sounds are recorded as magnetized regions on the wire

1893 Photographic Paper

Belgian chemist Leo H. Baekeland, working in New York, introduces a photographic paper called Velox; it allows printing to be done by artificial light, which revolutionizes photographic print-making

1893 Telephone System Battery

Lexington, Massachusetts, sees the first use of a centralized battery for speaking and signaling through a telephone system; use of a centralized battery reduces service interruptions, since it is a more reliable source of power for the telephone system

1894 Radio Equipment

Guglielmo Marconi, an Italian electrical engineer, builds primitive radio equipment; his device rings a bell from 30 feet (10 meters) away

1894 Radio Receiver

Edouard Branly of France uses his coherer to detect radio waves produced by a spark generator 100 feet (30 meters) away; his receiver is made of a battery, a coherer, and a galvanometer; as soon as the spark generator starts working, the galvanometer indicates a current and the coherer reacts to the presence of radio waves

1894 Radio Transmission

Englishman Oliver Lodge transmits radio signals 180 feet (60 meters) at the annual meeting of the British Association for the Advancement of Science

1894 Photocomposition

By projecting letters on a light-sensitive plate, Eugene Porzolt invents a photographic method for composing type; the system, now known as photocomposition, does not become commercially available for another 50 years

1895 Wireless Telegraph

During initial experiments on his father's estate, Italian electrical engineer Guglielmo Marconi sends wireless telegraph messages approximately one mile

1895 Cinematographe

French brothers Auguste and Louis Lumiere patent a projecting version of Thomas Edison’s Kinetoscope, called a cinematographe; the Lumieres use 16 frames per second and 35-mm film, both of which become early standards for the industry, when they demonstrate their first public showing of a motion picture using their process in a Parisian cafe in December

1895 Mutoscope

Inspired by Thomas Edison’s Kinetoscope, Herman Castler builds and patents the Mutoscope; the device is a rotating drum with a large number of cards mounted on it; when the viewer sees these cards move in rapid succession, the images appear to move; coin-operated versions of the Mutoscope soon appear in picture parlors

1895 Rembrandt Photogravure

In England, Karl Klietsch works with printer Samuel Fawcett to develop an improved form of mechanized photogravure on copper plates; the method is nicknamed Rembrandt photogravure and becomes popular early in the 20th century

1895 Typewriter

Englishman John T. Underwood begins manufacture of a typewriter patented in 1893 by Franz X. Wagner; it allows the typist to see the words as they are typed, as did the Oliver typewriter developed in 1892

1896 IBM

Herman Hollerith of Buffalo, New York, founds the Tabulating Machine Company after successfully applying his punched-card computing technique to the U.S. census; the company later becomes International Business Machines, eventually shortening its name to IBM

1896 Kodak Brownie Camera

American George Eastman’s photographic company, Eastman Kodak, develops and introduces the Brownie camera, initially priced at $1 in the United States; the simple camera is bought by millions of people who use it to take hundreds of millions of pictures

1896 Telephone Dialer

An unknown inventor in Milwaukee, Wisconsin, develops the telephone dialer; previously, telephones were connected by telephone operators; if an automatic exchange system has been installed, the dialer is not necessary, as the caller already has the option to touch a button to produce the pulses necessary to dial each number, rather than use an operator

1896 Marconi Telegraph

Italian electrical engineer Guglielmo Marconi arrives in England to demonstrate his improved telegraph system; this leads to the formation of the company that becomes the British Marconi Firm four years later

1897 Antenna

Russian physicist Alexander Popov transmits radio waves over a distance of 3 miles (5 kilometers) using an antenna

1897 Electron

Englishman Joseph John Thomson discovers the electron; this particle makes up electric current and is the first particle known to be smaller than an atom; his discovery is made possible in part by using better vacuum pumps than were previously available

1897 Mass to Charge Ratio

Working independently, Englishman Joseph John Thomson and E. Wiechert both determine the ratio of mass to the charge of particles by deflecting them in electric and magnetic fields

1897 Cathode Ray Tube

Karl Ferdinand Braun of Germany develops a cathode ray tube; he uses an evacuated electron tube in which electrons are aimed by electromagnetic fields to form an image on a fluorescent screen

1898 Wireless Demonstration

Nikola Tesla demonstrates advances in wireless technology by controlling model ships over radio waves in New York City

1899 Radio Link

Italian electrical engineer Guglielmo Marconi opens the first radio link between England and France, sending a greeting to the French scientist Edouard Branly

1899 Variable Focus Camera Lens

Thomas Dallmeyer develops a variable focus camera lens

1899 Photoemissive Effect

Phillip Lenard in Germany and Joseph John Thomson in England each demonstrate that the release of electrons causes the photoemissive effect of ultraviolet light on zinc

1900 Load Circuits

Load circuits are first used to reduce the distortion of telephone signals

1900 Automatic Card Feed

New Yorker Herman Hollerith, in order to better process the 1900 census data, adds an automatic card feed to his information tabulating machine

1900 Radio-frequency Alternator

Canadian inventor Reginald Aubrey Fessenden discovers how to produce AM radio signals with a radio-frequency alternator; several years of work are needed to improve the device

1900 Motion Picture

Raoul Grimoin-Sanson uses ten projectors to display a motion picture on a circular screen; spectators are in the middle of the room, and they see a moving image in all directions; a similar method of projection is used in 1951 under the name Cinerama

1900 Television

The term television is first used by Constantin Perskyi

1900 Photoelectric Cell

Germans Johann Phillip Elster and Hans F. Geitel devise the first practical photoelectric cell, which emits electrons when it is struck by light

1901 Transatlantic Wireless Telegraph

Guglielmo Marconi uses wireless telegraphy in St. Johns, Newfoundland, to receive the letter ÔS’ from England; it is the first transatlantic telegraphic radio transmission

1901 Spiral-groove Record

Emile Berliner introduces a black shellac disc with a spiral groove in which sound vibrations are recorded as sideways deflections

1901 Numerical Keyboard

New Yorker Herman Hollerith invents the first numerical keyboard, designed for punching the cards used in tabulating machines

1901 Heterodyne Principle

Canadian physicist Reginald Aubrey Fessenden discovers the heterodyne principle, a fundamental part of American inventor Edwin Armstrong’s development of the super-heterodyne radio receiver; the principle states that when two radio signals are mixed in a receiver, a third signal will be created with a frequency equal to the difference in frequency of the two signals that were received

1901 Electromagnetic Waves

William Du Bois Duddell discovers that electromagnetic waves can be generated by an electric arc; he does not develop this knowledge into applications for radio, as he fails to achieve frequencies higher than 10,000 Hz

1901 Telex Code

Donald Murray of New Zealand invents a five-digit code that will eventually become the basis for telex by 1930; the code is a way of communicating between two teletypewriters over regular telephone lines

1902 Fax

German physicist Arthur Korn finds a way to transmit photographs by breaking them down into several components, sending the components over telephone lines, and reconstructing them after transmission using selenium cells; this early fax machine quickly becomes indispensable to reporters, as it allows them to immediately transmit photographs of news events

1902 Electric Typewriter

The Blickensderfer Electric is invented by George Blickensderfer of Stamford, Connecticut; it is the first electric typewriter to be sold worldwide

1902 Color Television

Otto von Bronk files a patent application for color television in Germany

1903 Arc Transmitter

Valdemar Poulson of Denmark patents an arc transmitter capable of generating continuous radio waves; this produces a frequency of over 100 kHz that can be received at distances of more than 150 miles (240 kilometers)

1903 Mechanical Telephone Repeater

Herbert Shreeve installs mechanical telephone repeaters between Boston and Amesbury, Massachusetts; a metallic diaphragm is connected to a carbon transmitter, which produces sound when the diaphragm is set into motion by an incoming telephone signal; the device, however, delivers signals with very poor sound quality

1903 Automatic Telephone Switching

Bell Telephone Company begins researching development of an automatic telephone switching system

1904 Fleming Vacuum Tube

English inventor John Ambrose Fleming files a patent for his Fleming valve, the first vacuum tube; it is a diode tube that makes current flow in a single direction instead of alternating between two directions; also called a rectifier, it changes an alternating current (AC) into a direct current (DC)

1904 Alternator

Canadian physicist Reginald Aubrey Fessenden transmits speech through the modulation of a radio wave generated by his high-frequency alternator; a few years later he obtains better results by using a continuous-wave transmitter with vacuum tube oscillators

1904 Offset Printing

Ira W. Rubel invents offset printing when he uses a rubber ink pad to transfer an image from a lithographic plate to a sheet of paper

1904 Typewriter

The American typewriter manufacturing firm of L. C. Smith & Bros. produces a replacement for its Premier typewriter, which had required separate keyboards for upper and lower case type; the new model has a shift key to handle upper case and only needs one keyboard

1905 Adjustable Antenna

Italian electrical engineer Guglielmo Marconi builds a radio antenna that can be adjusted to face different directions

1905 Photoemissive Effect

Albert Einstein explains the photoemissive effect in *The Electrodynamics of Moving Bodies,* articulating for the first time the idea that an entity can simultaneously be a wave and a particle; he wins the Nobel Prize in Physics 16 years later for his explanation of how the frequency of light striking metal, rather than the intensity of the light, causes variations in the release of electrons from the piece of metal

1906 Broadcast Radio

Canadian inventor Reginald Aubrey Fessenden transmits music and speech to ships at sea equipped with receivers by using a high-frequency alternator and radio waves; Fessenden calls the transmission wireless telephony, but it is actually an early example of AM radio since the intensity of the radio waves varies according to the audio signals being transmitted; during the broadcast, Fessenden requests that anyone hearing the signal write to him, prompting people to contact him from as far away as the West Indies

1906 Image Transmission

German physicist Arthur Korn transmits images over a distance of 1,000 miles (1,600 kilometers) using telegraph lines

1906 Photostat

The photostat comes into use, allowing each image to be individually sized as it is produced; the photostatic images are made by using a special camera and coated paper instead of film, and can be in the form of a black-and-white photograph, a piece of art, or a printed page

1907 Amplifier Vacuum Tube

Working in America, Lee de Forest and R. von Lieben invent the triode, or amplifier vacuum tube; its design is based on John Ambrose Fleming's two-element vacuum tube but features the addition of a grid located between the cathode and anode; the grid allows very small voltage changes to determine the modulation of the electric current through the valve

1907 Television Receiver

Boris Rosing receives a crude television transmission by using photocells and a Braun tube; the receiver in the system is electronic and the television camera is mechanical

1907 Telephotography

German physicist Arthur Korn inaugurates the commercial use of telephotography by telegraphing a photograph from Munich to Berlin

1907 Color Photography

In France, Auguste and Louis Lumiere develop the first color photography system suitable for use by amateur photographers

1907 Radio Generator

Reginald Aubrey Fessenden of Canada and Ernst F. W. Alexanderson of Sweden invent a high-frequency electric generator in America that is capable of producing radio waves with a frequency as high as 100 kHz; the device is suitable for radio communication purposes

1908 Color Photography

French physicist Gabriel Jonas Lippmann is awarded the Nobel Prize in Physics for inventing the first practical form of color photography in 1891

1909 Wireless Telegraphy

Guglielmo Marconi of Italy and Karl Ferdinand Braun of Germany share the Nobel Prize in Physics for developing wireless telegraphy

1910 Automatic Telephone Exchange

In the United States, the first automatic telephone exchanges are available; over 7 million telephones are in use, nearly all of them having been rented by AT&T to its customers

1910 Multiplexing

Telephone systems are successfully multiplexed for the first time, allowing multiple signals to be transmitted simultaneously over the same line

1910 Radio Arrest

The captain of a British ship, the *Montrose,* observes an escaped murderer, Dr. Crippen, onboard; the captain alerts Scotland Yard to this fact, resulting in Crippen's capture and much publicity for the usefulness of radio communications

1911 Television Scanning System

Campbell Swinton describes an all-electronic television scanning system using cathode ray tubes in both the transmitter and the receiver; this is the basis for the television systems still in use today

1911 IBM

Under the guidance of New York executive Herman Hollerith, the Tabulating Machine Company merges with two other computing firms to become the Computing Tabulating Recording Company (later to become IBM); his tabulating machines are also used this year in the British census for the first time

1912 Radio Act

The first regulations for land-based radio stations and amateur radio operators are established by the Radio Act of 1912

1912 Automatic Telephone Exchange

In England, the first automatic telephone exchange is opened in Epson by the Post Office, which has authority over all British telephone communications

1912 Color Photography

A subtractive form of color photography, using color dyes embedded in three layers of emulsion on the film, is developed by Siegrist and Fisher; this method is a predecessor of the Agfacolour and Kodachrome color photography processes

1912 Amplifier

American Lee de Forest increases the transmitted strength of audio signals 120 times through the use of his three-tube audion amplifier

1913 Heterodyne Radio Receiver

The heterodyne radio receiver is introduced

1913 Audion Repeaters

Weak signals are amplified by vacuum triodes in telephone line repeaters on the New York to Baltimore line; the devices are called audion repeaters

1913 Fax

Edouard Belin invents the Belinograph, a form of portable facsimile (fax) machine called the Belino by reporters of the time; it quickly replaces Arthur Korn's facsimile machine, and is capable of using ordinary telephone lines

1913 Motion Pictures

The term movie is first used for motion pictures

1914 Radio Receiver Circuit

On October 6th, Edwin H. Armstrong of New York City patents a radio receiver circuit with positive feedback that he designed at Columbia University while a student there; selectivity and sensitivity of audio signals are enhanced by feeding part of the amplified high-frequency signal to the tuning circuit

1914 Fax

The first remote photo news story is sent from World War I using Edouard Belin’s Belino portable fax machine

1914 Teletypewriter

Edward Kleinschmidt of Germany develops the teletypewriter

1915 Telephone Cables

Underground telephone cables connect London and Birmingham, England, while overhead telephone cables begin to disappear from cities

1915 Radiotelephone

The first transatlantic radiotelephone call is made between Arlington, Virginia and the Eiffel Tower in Paris; radiotelephone technology later becomes a vital means of communications for field troops during wartime, allowing soldiers in remote areas to stay in contact with operation centers

1915 Transcontinental Telephone Call

The first transcontinental telephone call in North America is between Alexander Graham Bell in New York City and Thomas A. Watson in San Francisco; from a distance of 3,000 miles (4,800 kilometers), Bell says Mr. Watson, come here, I want you, repeating the first telephone message of March 10, 1876; seven repeater stations amplify the telephone signals being carried between the east and west coasts of the United States

1915 Germanium Crystal

Manson Benedicks, an American physicist, discovers that AC current can be converted to DC by a germanium crystal; this discovery contributes to the development of computer chips

1915 Dynatron Vacuum Tube

Albert W. Hull patents a vacuum tube in which any measurable increase in anode voltage results in a corresponding decreasing of the anode current; this is because the anode releases a secondary emission of electrons, altering the reaction in the vacuum tube; the tube is called a dynatron

1917 Alternator

Designed by Ernst F. W. Alexanderson of Sweden, a 50 kilowatt electronic alternator begins operating in New Brunswick, New Jersey, at the naval center known as Station NFF

1917 Condenser Microphone

E. C. Wente invents the condenser microphone

1917 Neutrodyne Circuit

L. A. Hezeltine develops the neutrodyne circuit

1918 Superheterodyne Radio Receiver

Edwin H. Armstrong develops the superheterodyne radio receiver in New York; incoming signals are mixed with signals from an internal oscillator that is simultaneously tuned with the receiving circuit; the mixed signals are transformed to a lower fixed frequency called the intermediate frequency before being amplified and demodulated; this principle forms the basis behind all radio receivers in use today

1918 Alternator

The most powerful radio transmitter built to date, a 200 kilowatt (kW) alternator, replaces Alexanderson’s 50 kW alternator at Station NFF, the naval station at New Brunswick, New Jersey

1918 Binary System

J. Abraham and E. Bloch build a computing machine based on the binary system using the numbers zero and one, where zero represents an open switch and one a closed switch

1919 RCA

The Radio Corporation of America (RCA) is founded

1919 Television Scanning System

Charles Francis Jenkins of Dayton, Ohio, files an application for a patent on his television system, which uses spinning prismatic rings in a scanning system very similar to that of Paul Nipkow

1919 Flip-flop Circuits

William H. Eccles and F. W. Jordan publish a paper in England on flip-flop circuits, which become important components in electronic computers two decades later; flip-flop circuits remember to switch between a one and a zero when performing applications in a binary computer system

1919 Enigma

Hugo Koch invents the Enigma, a data encoding machine with 22 million possible combinations; Germany uses the machine to encrypt messages in World War II

1920 KDKA

The Westinghouse Electric and Manufacturing Company establishes the first radio station, KDKA in East Pittsburgh, Pennsylvania, partly to encourage radio receiver sales; KDKA is the first station to transmit presidential election results

1920 Motion Pictures

American Lee de Forest develops a system that will be used in the first talking motion pictures to synchronize sound with pictures on separate tracks of cinematic film using a photoelectric cell

1921 Short-wave Radio

The American Radio League establishes contact with Paul Godley in Scotland over a short-wave radio; this provides the first evidence that short-wave radio is suitable for use in communicating over long distances

1921 Magnetron Vacuum Tube

Albert W. Hull invents an early magnetron; microwaves are produced by placing an electron tube in a magnetic field; normal vacuum tubes of the time could not oscillate at microwave frequencies

1921 Quartz Crystals

Walter Cray discovers the stabilizing properties of quartz crystals

1922 Radio Regulation

Herbert Clark Hoover, Secretary of Commerce under President Warren G. Harding, hosts the first government conference on radio in Washington, D.C., calling for the regulation of radio technology, allowing limited advertising on radio stations, and classifying stations based on the kind of service each one offers

1922 Radio Waves

Frequency-modulated (FM) radio is described by American mathematician John R. Carson using the mathematics of waves

1923 Iconoscope

Russian inventor Vladimir Kosma Zworykin files a patent for the iconoscope, a totally electronic tube for television cameras

1923 Wireless Fax

Charles Frances Jenkins of Dayton, Ohio, transmits silhouettes from Washington, D.C., to Philadelphia, Pennsylvania, using wireless facsimile

1923 Radio Network

The first radio network multiple-station hookup is formed by the stations WEAF, WGY, KDKA, and KYW; the setup uses telephone lines for network broadcasting and is operated by AT&T

1923 16-mm Film

American photographer and inventor George Eastman develops 16-mm negative film for use by amateurs; Bell & Howell and the Victor Animatograph Company begin marketing 16-mm cameras and projectors in less than one year

1924 IBM

International Business Machines, Herman Hollerith’s computing company, shortens its name to IBM

1924 Portable Radio

Zenith produces the first portable radio designed for general consumer use; the radio is priced at $230, weighs 14.6 pounds (6.6 kilograms), and is as large as a suitcase

1924 Radio Waves

Photographs are transmitted on radio waves between New York City and London

1924 36-mm Camera

The first 24-mm x 36-mm camera, called the Leica, is introduced by the German company Leitz

1925 Sound Recording

Electrical sound recording is introduced; microphones are used to capture the sound before it is changed into electric currents and converted into a mechanized form to be recorded on the master disk

1925 Gray Scale Definition

John Logie Baird of Scotland produces a television image of a human face using gray scales to achieve definition of facial features

1925 Wireless TV Broadcast

Charles Jenkins of Dayton, Ohio, transmits the first wireless moving television silhouettes by using radio waves

1925 Color Television

Russian inventor Vladimir Zworykin applies for a patent on his color television system

1925 Anamorphic Objective Lens

French astronomer Henri Jacques Chretien invents the anamorphic objective lens, a device that compresses images laterally and will be used for CinemaScope films starting in 1952

1925 AT&T

AT&T introduces the first commercial wirephoto service

1926 Transatlantic Telephone

Transatlantic telephone signals are transmitted via short-wave radio

1926 Motion Pictures

The era of talking motion pictures begins with the movie *The Jazz Singer*, starring Al Jolson

1926 RCA Radiophoto

RCA opens the first commercial transatlantic radiophoto transmission service

1926 Television Transmission

John Logie Baird of Scotland uses the Nipkow disk to produce moving television pictures; Baird also successfully transmits silhouette images via telephone lines between London and Glasgow, Scotland

1926 Crocker Research Laboratories

Philo T. Farnsworth of Beaver, Utah, founds Crocker Research Laboratories to study televised transmission of pictures

1927 Image Transmission

Frederick E. Ives of Litchfield, Connecticut, transmits still and moving images, accompanied by synchronized sound, by wire

1927 Sound Recording

J. A. Neill improves magnetic sound recording and creates an early tape recorder by using metal-coated diamagnetic tape in place of the steel wire used in Valdemar Poulson’s sound recorder of 1893

1927 Videodisk

John Logie Baird of Scotland invents the first videodisk system

1927 Picturephone

Herbert Hoover, Secretary of Commerce under President Calvin Coolidge, and Walter Sherman Gifford, president of AT&T, use the first known picturephone; the conversation is carried over telephone lines while television cameras and receivers equipped with Nipkow disks transmit pictures

1927 Typewriter

The Schulz Player Piano Company, using the same basic mechanism that operates a player piano, develops the Auto-typist typewriter; the typewriter produces multiple copies of the same document by making an original copy on a punched paper roll, with each punched hole representing a letter to be typed; this is neither the first nor last typewriter to use a punched paper roll, but this version succeeds in making the idea popular

1927 Data Measurement

Ralph V. L. Hartley of Spruce, Nevada, introduces the concept of using the amount of information in a message to measure the quantity of data the message contains

1927 Pentode Vacuum Tube

A vacuum tube with five electrodes, the pentode, is introduced by Philips of Holland

1927 Differential Analyzer

Vannevar Bush of Everett, Massachusetts, develops the Differential Analyzer with coworkers at MIT; the machine is an electromechanical analog computer that can solve differential equations

1928 Broadcast Television Begins

Hugo Gernsback’s radio station in New York City, WRNY, begins to broadcast television shows after encouraging radio listeners to build television sets with Nipkow disks; programming on the first day includes a fitness show, concerts, a cooking demonstration, and a lecture by Gernsback; the operation is abandoned a year later when Gernsback goes bankrupt

1928 Dissector Tube

Philo T. Farnsworth of Beaver, Utah, builds the dissector tube, useful in television development; the tube is a television camera that dissects images into multiple parts and reassembles them after transmission, completely reproducing the first image

1928 Broadcast Television

General Electric begins television broadcasts

1928 Instant Film

Agfa, a German manufacturer of photographic supplies, invents a film that develops instantaneously; Edwin H. Land uses this film for inspiration when he designs his Polaroid camera 20 years later

1928 Color Television

Russian inventor Vladimir Zworykin receives a patent for his color television system developed three years earlier

1928 Television Transmission

John Logie Baird of Scotland transmits television pictures across the Atlantic Ocean

1929 Sound Recording

Dr. Fritz Pfleumer develops a plastic tape with magnetic coating suitable for recording sound

1929 NBC Television

The National Broadcasting Company (NBC) begins broadcasting black-and-white television signals with 60 scanning lines at 20 frames per second, offering low-quality pictures

1929 Color Television

Bell Labs develops a color television system featuring 50 scanning lines at 17.7 frames per second

1929 BBC Television

The British Broadcasting Corporation (BBC) uses John Logie Baird's television system to begin experimental broadcasts

1929 Video Telephone

Gunter Krawinkel of Germany introduces the first video telephone booth

1931 CBS Television

The Columbia Broadcasting System (CBS) begins television broadcasting

1931 Photo-electric Integraph

Truman S. Gray of Spencer, Indiana, invents the photo-electric integraph, a calculating machine capable of solving complex mathematical problems by converting them to rays of light

1932 Lapel Microphone

The lapel microphone is developed

1932 RCA Television

RCA makes experimental broadcasts from the Empire State Building in New York City to demonstrate a television receiver with a cathode ray picture tube; the cathode ray tube makes high-quality television reception a reality

1932 Educational Television

The University of Iowa begins broadcasting regularly scheduled educational programs using a mechanical system similar to those developed by Nipkow and Baird; the station stays on the air until 1939

1932 TV Camera

Scientists working for Electrical and Musical Industries, Ltd. (EMI) design, build, and patent a successful electronic television camera

1932 Car Radio

The first car radio is installed in a Studebaker by Blaupunkt, a German radio manufacturer

1932 Microwaves

Italian electrical engineer Guglielmo Marconi detects very high frequency radio waves, known as microwaves; the waves are used in the radar systems developed a decade later

1933 Stereophonic Recording

Alan Dover Blumlein pioneers stereophonic recording, in which two tracks of sound are recorded in a single groove and then replayed through one stylus to separate amplifiers

1933 FM Radio

Edwin H. Armstrong of New York City patents wide-band frequency modulation (FM) radio

1933 Sound Recording

American inventors Franklin V. Hunt, John Pierce, and J. A. Lewis improve the sound quality of records by introducing lateral engraving of the grooves

1934 FCC

Roosevelt signs the Communications Act of 1934 into law, establishing the Federal Communications Commission (FCC)

1935 Magnetophone

The Magnetophone, manufactured in Germany, becomes the first commercially marketed tape recorder to use magnetized plastic tape

1935 Kodachrome

Kodak develops the Kodachrome system for producing color photographs

1935 IBM Typewriter

IBM introduces its electric typewriter, which becomes a standard piece of office equipment

1936 BBC Television

The British Broadcasting Corporation (BBC) adopts EMI's electric television camera system and begins regular public daily television broadcasts in Great Britain; these transmissions are the first regular electronic public television service anywhere (Gernsback's broadcasts in 1928 used a mechanical scanning system)

1936 Olympic Games

The Olympic Games are televised from Berlin

1936 Picturephone

In Germany, the Reichspost develops a picturephone network between Berlin, Leipzig, Nuremberg, and Hamburg; coaxial cables transmit the pictures, which are scanned at 180 lines

1936 Penning Trap

Frans Michel Penning, an engineer, finds a way to confine electrical currents to radio tubes; the method is later modified to contain electrons and is named the Penning Trap

1936 Digital Computer

Konrad Zuse of Germany begins work on a primitive form of digital computer using parts similar to those found in an Erector Set

1937 Turing Machine

Alan M. Turing of England publishes *On Computable Numbers*; the now-celebrated paper builds on the work of Bertrand Russell and Charles Babbage and introduces the Turing machine, a theoretical model of an imaginary computer developed in 1935; the paper establishes a definition of computable, stating that any computable problem can be solved by the Turing machine

1937 Church-Turing Thesis

Alan M. Turing and Alonzo Church independently develop what comes to be known as the Church-Turing thesis, the theory that all problems that a human being can solve can be reduced to a set of algorithms; since machines can solve algorithms, this theory essentially means that machine intelligence and human intelligence are equivalent

1937 Portable TV Transmission

Outdoor television broadcasts begin in London, using portable transmitters

1937 Xerography

American law student Chester Carlson invents xerography, the first method of copying to be based on the light-sensitive properties of selenium; the results are initially very crude, and it is several years before Carlson develops a commercially viable product

1937 Sound Transmission

Alec Reeves in England describes a method of sound transmission that converts analog sound into electrical pulses by a sampling process before transmission; after the sounds are received, the pulses are transformed back into an analog sound signal

1937 Electronic Computer

American physicist John V. Atanasoff of Hamilton, New York, begins developing the first electronic computer with the eventual goal of using it to solve systems of linear equations; even though this computer is electronic, it is not programmable

1937 Binary Circuit

While working for Bell Telephone Laboratories, mathematician Georges Stibitz of York, Pennsylvania, develops the first binary circuit, which uses Boolean algebra to add two binary numbers; he builds the combination of batteries, lights, and wires in his kitchen, and he calls the device the model K or kitchen adder; this circuit contributes to the development of other electromechanical computers at Bell Labs

1937 Klystron Vacuum Tube

American brothers Russel H. and Sigurd Fergus Varian develop a vacuum tube that generates microwaves; called a klystron, the invention will be used in radar transmitters

1938 W2XMN

Edwin H. Armstrong’s New Jersey radio station, W2XMN, goes on the air

1938 Vestigial Sideband TV Filter

George Harold Brown doubles the horizontal resolution of television pictures by developing the vestigial sideband filter for use in television transmitters

1938 Experiential Learning

American engineer Thomas Ross develops a mechanical mouse that learns through trial and error to find its way through mazes; it runs on train tracks and is the first machine that learns from experience

1938 Mathematical Theory of Information

Claude Elwood Shannon of Gaylord, Michigan, writes *A Symbolic Analysis of Relay and Switching Circuits,* one of the earliest papers to address the mathematical theory of information

1938 Binary Code

German scientist Konrad Zuse completes the Z1, the first operational computer to use a binary code in information processing

1939 NBC Television

NBC begins regular television programming with the opening of the World’s Fair in New York City

1939 Orthicon Camera Tube

Albert Rose and Harley Iams develop the orthicon television camera tube at the RCA Laboratories; an electron beam scans the mosaic plate where the image is projected; the electron beam then resupplies the electrons that have been released by photoemission after they are recovered by an electron collector

1939 Image Iconoscope Camera Tube

Vladimir K. Zworykin, Harley Iams, and an assistant develop the image iconoscope television camera tube, featuring a semi-transparent photocathode where the televised image is projected before being broadcast

1939 Color Photography

The first commercial system of color photography in which a negative is produced is introduced; the system becomes popular with skilled amateur photographers, professional photographers, and cinematographers

1939 Magnetron Vacuum Tube

Englishmen John Turon Randall and Henry Albert Boot develop the first practical magnetron, building on work done in the preceding twenty years; the device is a vacuum tube that produces radio waves of greater power and higher frequency than previously possible; the Randall-Boot magnetron becomes the primary component of radar systems after it is secretly brought to the United States

1939 Complex Number Computer

Mathematician Georges Stibitz of York, Pennsylvania, and Samuel B. Williams, an inventor, build the Complex Number Computer; they introduce the concept of operating a computer from a remote terminal by attaching the device in New York City to three telex machines and controlling it at Dartmouth College in Hanover, New Hampshire; also called the Bell Telephone Lab Computer Model 1 or BTL Model 1, the computer consists of more than 400 relays

1939 Electronic Computer

The first working prototype of John V. Atanasoff’s electronic computer is unveiled

1940 CBS Color Television

The first U.S. color television broadcast is made using a system developed for CBS by Peter Carl Goldmark

1940 Ultra

Alan M. Turing is among the group of computer, engineering, and encryption intellectuals working at Bletchley Park in England to defeat Enigma, the German encoding machine designed by Hugo Koch more than two decades earlier; the group, collectively called Ultra, develops a series of computers dedicated to decoding messages sent between German military forces; the British computer system, called Robinson, is based on electromechanical relays

1940 Z2 Computer

Konrad Zuse completes the Z2 with financial aid from the German government; the binary-coded computer is similar in design to the Z1 but replaces mechanical logical circuits with telephone relays

1941 Commercial TV

The Federal Communications Commission (FCC) issues the first television broadcast license; transmission standards are set at 525 scanning lines and 30 frames per second; the FCC also grants broadcasters permission to finance programs by airing commercials, prompting NBC and CBS to include commercials in their New York City broadcasting

1941 FM Radio

Edwin H. Armstrong, the inventor of FM radio, helps the Radio Club of Columbia University open radio station WKCR

1941 Z3 Computer

Konrad Zuse of Germany completes the Z3, the first fully programmable digital computer, and hires Arnold Fast, a mathematician, to be the first person to program a programmable computer that is truly operational; the computer has 2,600 relays, uses a punched tape for data entry, and employs a code to detect programming errors

1941 Chain Broadcasting Report

The Federal Communications Commission (FCC) issues the Chain Broadcasting Report with eight important recommendations, including the stipulation that NBC must give up one of its two television networks (known at the time as the Red network and the Blue network)

1941 FCC Investigation

The Federal Communications Commission (FCC) begins a 2 1/2 year investigation into the newspaper ownership of radio stations

1942 Semiconductors

William B. Shockley of Bell Labs begins researching the replacement of vacuum tubes with semiconductors; this work leads to the development of the transistor in 1947

1943 ABC Computer

Physicist John V. Atanasoff of Hamilton, New York, and his student Clifford Berry build an operational model of an electronic calculating machine called ABC (Atanasoff Berry Computer); the invention uses vacuum tubes, logic circuits, and memory to solve systems of linear equations; the machine fails frequently because of problems with the punched-card input

1943 Colossus Computer

T. H. Flowers and M. H. A. Newman, working in the Ultra group headed by Alan M. Turing at Bletchley Park, England, design the Colossus; the computer has 1,500 vacuum tubes and is used to decipher German coded messages; it is the first all-electronic calculating device to be built

1943 Vacuum Tubes in Computing

John W. Mauchly of Cincinnati, Ohio, publishes his report, *The Use of a High-Speed Vacuum Tube Device for Calculating,* arguing that using vacuum tubes in computers would be considerably faster than the existing practice of using electromechanical relays; Mauchly, John Presper Eckert of Philadelphia, Pennsylvania and John Gerard Brainerd of Bradford, England, design the ENIAC computer following this principle

1943 Chain Broadcasting Report Upheld

The Supreme Court upholds the chain broadcasting regulations implemented by the Federal Communications Commission (FCC) two years earlier; NBC is forced to relinquish control of one network; the regulations also forbid exclusivity and curtail option time

1944 Aiken Mark I Computer

Howard H. Aiken, a computer engineer and mathematician from Hoboken, New Jersey, completes the first American programmable computer while working at Harvard with a team of engineers from IBM; the Mark I (officially the Automatic Sequence Controlled Calculator) uses punched paper tape for programming and vacuum tubes to calculate problems, but it breaks down frequently

1944 Stored-Program Concept

Upon accidentally meeting Hungarian-born American mathematician John von Neumann, Herman Goldstine of Chicago, Illinois, mentions plans to build the ENIAC computer; after this conversation, von Neumann becomes involved in the design of early computer architecture, including the stored-program concept

1944 Computer Memory

John Presper Eckert of Philadelphia, Pennsylvania, and John W. Mauchly of Cincinnati, Ohio, develop the mercury delay line store, an early form of computer memory; the design stores data as acoustic pulses running down a mercury-filled tube; Eckert also proposes building a device he calls the Magnetic Calculating Machine, which would store numbers and instructions on spinning drums covered with a magnetized material; the stored data would be read by coils placed close to the magnetized surface

1944 FCC Investigation Ends

The Federal Communications Commission (FCC) ends its 2-1/2 year investigation into newspaper ownership of radio stations without recommending any changes

1945 ABC

NBC’s Blue network becomes the American Broadcasting Company (ABC)

1945 Geosynchronous Satellite

Arthur C. Clarke, an author from Somerset, England, writes about the possibility of a geosynchronous satellite; a satellite of this type would remain in a fixed position over the same spot on Earth by revolving at the speed of the planet's rotation

1945 Valve Video Projector

The Eidophor is the first practical light-tube, or valve video projector

1945 Computer Bug

Navy Captain Grace Murray Hopper, assigned to Howard Aiken's Mark I computer project, coins the term bug to indicate a problem with the operation of a computer program; the term arose because a problem she was having with her computer was found to be caused by a moth inside the machine

1945 Von Neumann Architecture

Hungarian-born American mathematician John von Neumann begins researching computers at the Institute for Advanced Studies in Princeton, New Jersey; while there he writes *First Draft of Report on the EDVAC* (the Electronic Discrete Variable Computer), defining the von Neumann architecture for computers

1946 Microwaves

High-frequency microwaves are used to transmit telephone signals; up to this time, microwaves have chiefly been used in radar systems

1946 Assembler Language

Maurice V. Wilkes of Dudley, England, develops an early version of the Assembler programming language that will considerably simplify computer programming; Assembler is considered a mnemotechnic language because it uses abbreviated commands, such as *add* for addition and *def* for define; these shortcuts allow the programmer to avoid memorizing complex sets of information when programming simple instructions

1946 Mobile Telephones

The first mobile telephones are introduced

1946 Image Orthicon Camera Tube

Albert Rose, Paul K. Weimer, and Harold B. Law develop the image orthicon television camera, an improved version of the orthicon with excellent light sensitivity; it becomes widely used by television companies

1946 ENIAC

John Presper Eckert of Philadelphia, Pennsylvania, and John W. Mauchly of Cincinnati, Ohio, demonstrate ENIAC to scientists and industrialists; developed secretly during World War II, ENIAC is the world's first fully electronic, programmable digital computer; instead of using binary numbers, its vacuum tubes are arranged to display numerals; it is nearly 1,000 times faster than Howard Aiken's Mark I computer, but lights dim in neighboring towns every time the machine is used; early press releases about the invention claim that it can multiply 360 ten-digit numbers or extract a square root in a single second

1947 Transistor

William Bradford Shockley, Walter Hauser Brattain, and John Bardeen, working at Bell Labs, first recognize the transistor effect after performing an experiment; they report the discovery to Bell Labs management on December 23, and the transistor is unveiled in 1948 to the general public; this tiny device functions much like a vacuum tube but switches current on and off much more quickly; the use of transistors in microelectronics launches a revolution, lowering the cost of computers and leading to the development of both minicomputers and powerful mainframe computers

1947 Artificial Intelligence

English mathematician Alan M. Turing publishes an article on intelligent machinery, launching the field of artificial intelligence

1947 Cable Television

Zenith announces the Phonevision system of paying for television services delivered over wire, initiating two decades of experimentation and intense debate revolving around cable television

1947 Television Connections

Television stations in the eastern and midwestern United States are interconnected by microwave links and coaxial cables

1947 Holography

Hungarian-born English physicist Dennis Gabor develops the concept of holography, although holograms are an impractical invention until after the advent of the laser

1947 Instant Film

Edwin Herbert Land of Bridgeport, Connecticut introduces a camera that develops pictures inside itself in about a minute; Land's work is based on an invention made but never commercialized by the German company Agfa in 1928

1948 Radio Circuits

John Sargrove introduces printed radio circuits

1948 Long-playing Record

The long-playing 12 inch record disk, made of vinylite and spinning at 33 1/3 rpm, is designed by Hungarian-born English physicist Peter Mark Goldmark and introduced by Columbia Records

1948 Transistor Radio

Bell Labs introduces transistor radios, greatly reducing the size of a radio set

1948 Magnetic Memory

The idea of using a magnetic drum storing computer data is introduced; the system consists of a spinning drum covered with magnetic film that stores encoded data in tiny magnetized domains

1948 Gerber Television Standard

The Gerber television standard of 625 scanning lines and 25 frames per second is adopted in Europe

1948 Kilburn Mark I Computer

The prototype of Tom Kilburn's Mark I computer (not to be confused with Howard Aiken's computer of the same name) begins operating at Manchester University in England; it is a stored-program electronic computer that utilizes von Neumann architecture and stores data in cathode ray tubes

1948 Cable Television

The first cable television systems appear in the United States and are called Community Antenna Television (CATV); remote communities receive broadcast television signals via a system of twin lead and coaxial cables; electronic equipment is frequently modified by CATV engineers to meet the requirements of signal transmission

1948 IBM SSEC

IBM introduces the Selective Sequence Electronic Calculator (SSEC), an electromechanical computing device that uses electronic circuits for storing data and performing calculations

1948 Audio Recorder

Ampex develops the first audio recorder in the United States using magnetic tape

1949 Closed-circuit TV

The first closed-circuit television system is installed in Guy’s Hospital in London

1949 7 Inch Record

RCA introduces the 7 inch record that rotates at 45 rpm

1949 Photocomposition

Photon introduces the first modern photocomposition system, the Lumitype 200, in the United States; when it is made commercially available five years later, the machine can set between 30,000 and 50,000 characters per hour

1949 Short Code

John W. Mauchly of Cincinnati, Ohio, develops the Short Code, allowing computers to recognize two-digit mathematical codes; the Short Code is the first high-level programming language

1949 Mathematical Theory of Information

Working from his dissertation of a decade earlier, Claude Elwood Shannon of Gaylord, Michigan, publishes *The Mathematical Theory of Communication* ; he argues that information is a measurable quantity and uses that premise to establish basic rules governing communication of all forms, including electronic

1949 BINAC

John W. Mauchly of Cincinnati, Ohio, and John Presper Eckert of Philadelphia, Pennsylvania, build BINAC, the Binary Automatic Computer; the first electronic stored-program computer in the United States, it uses magnetic tape as its storage medium

1949 ILLIAC I

The ILLIAC I is built at the University of Illinois in Urbana-Champaign; the computer uses von Neumann architecture as described in several unpublished works written by John von Neumann in 1945 and 1946; the U.S. Army simultaneously builds the ORDVAC computer, also using von Neumann architecture, at the Aberdeen Proving Ground

1949 EDSAC

Maurice V. Wilkes of Dudley, England, influenced by the work of Americans Eckert and Mauchly, builds EDSAC (Electronic Delay Storage Automatic Calculator) at Cambridge University; storing data in mercury delay lines, the machine contains only 3,000 vacuum tubes but processes data six times faster than previous machines

1949 Ferrite Core Memory

Jay Forrester of Anselmo, Nebraska, develops ferrite core memory for computers and uses his invention in the Whirlwind computer

1949 Fairness Doctrine

The Federal Communications Commission (FCC) rules that broadcasters may take editorial positions if opposing views are treated fairly; this lays the concrete foundation for the later establishment of the Fairness Doctrine

1950’s   Hi-Fi Sound

High-Fidelity (hi-fi) sound is developed and becomes very popular

1950 Phonevision

The Federal Communications Commission (FCC) allows Zenith to run trial tests of Phonevision in Chicago for 90 days

1950 Vidicon Camera Tube

Paul K. Weimer, Stanley V. Forge, and Robert R. Goodrich develop the vidicon television camera tube, which will be marketed by RCA; the tube operates on the same principle as the orthicon tube

1950 Kodachrome

A form of Kodachrome film for color photography is first marketed; the film uses chemical masks in the negative-developing emulsion to improve the quality of prints

1950 Eckert-Mauchly Computer Corp.

John W. Mauchly of Cincinnati, Ohio, and John Presper Eckert of Philadelphia, Pennsylvania, found their own company with the goal of commercializing computers; the company is called the Eckert-Mauchly Computer Corporation, but it fails when investors refuse to buy stock, believing that computers may be a Communist plot

1950 SAGE

The U.S. Air Force begins the SAGE (Semi Automatic Ground Environment) system to collect data from radar stations and other sources to be processed in the Whirlwind computer system (developed by Jay Forrester at the Massachusetts Institute of Technology) in real time; this is the first computer to operate in real time

1950 *Can a Machine Think?*

English mathematician Alan M. Turing proposes a test to determine whether a computer has real intelligence in an article titled, *Can a Machine Think?,* appearing in the journal *Mind*; the Turing test, as it comes to be known, is conducted by placing a group of several people with computer keyboards and monitors in one room and only one person and one computer in the adjoining room; the group of works without knowing if it is communicating with a person or a machine in the adjoining room; as the group directs questions to the other room, either the computer or the person answers; the goal of the Turing test is to convince the group that an answer put forth by the computer actually came from a human; when this happens, a computer will have passed the test by successfully simulating human thought patterns and responses

1951 Transcontinental TV

Transcontinental black and white television broadcasting begins in the United States

1951 Microprogramming

Maurice V. Wilkes of Dudley, England, introduces the concept of microprogramming

1951 Magnetic Memory

The U.S. military supercomputer Atlas is equipped with magnetic drums that offer a memory capacity of one megabyte

1951 Computer Programming

The first book on computer programming is published

1951 AO Compiler

Navy Captain Grace Murray Hopper, working with the Mark computer project in New York City, develops the compiler, called the A0, to translate programming code into binary machine code

1951 UNIVAC

The U.S. census is first handled by a programmable computer, the UNIVAC machine developed by Eckert and Mauchly; this becomes the first computer to be commercially marketed and features 100 mercury delay lines and 5,000 vacuum tubes

1951 Kilburn Mark I Computer

Ferranti introduces the first commercial computer to be based on Tom Kilburn's Mark I computer developed at Manchester University; the commercial product is also called the Mark I

1951 Buffer Memory

Remington Rand introduces buffer memory, a temporary memory that stores data to or from slow computer accessories and frees the central processor for other tasks

1951 Junction Transistor

William Shockley, Stanley Morgan, Morgan Sparks, and Gordon Teal develop the junction transistor by growing crystals in the laboratory

1951 Videotape Recorder

Armour Research develops a videotape recorder (VTR) that uses magnetic tape; Armour demonstrates the device to Ampex (an electronics design firm), inspiring Ampex to begin its own research into videotape recording

1951 NCAC

The National Community Antenna Council (NCAC) is organized; it is the forerunner of the National Cable Television Association (NCTA)

1952 IBM 701

IBM’s first production-line electronic digital computer, the 701, is developed by Bob Overton Evans and coworkers; it is marketed for scientific use; the 701, also called the Defense Calculator, has an electrostatic memory of 4,096 words; it is a 36-bit computer with von Neumann architecture; only 19 IBM 701 computers are built

1952 IAS

The IAS computer, featuring von Neumann architecture and parallel processing, is built at the Institute of Advanced Studies in Princeton, New Jersey

1952 UNIVAC

The CBS television network predicts the U.S. presidential election using a UNIVAC computer; the computer operators do not believe the initial prediction of a landslide victory and quickly reprogram the computer to predict a close race; in fact, General Dwight David Eisenhower won the election with the vast majority of votes

1952 UHF TV

The Federal Communications Commission (FCC) authorizes UHF (ultra-high frequency) television broadcasting in the U.S.

1952 Junction Transistor

The first hearing aids to use junction transistors appear on the market; Bell Laboratories waives all patent royalties on hearing aid applications for the transistor, continuing the commitment the company has shown to helping the deaf since the time of Alexander Graham Bell

1952 FCC

The first major amendments to the Communications Act of 1934 become law, allowing the Federal Communications Commission to issue cease-and-desist orders as well as revoke licenses in radio and television regulation

1952 NCATA

The National Community Antenna Television Association (NCATA) is organized in Pottstown, Pennsylvania

1953 UNIVAC Printer

Remington Rand develops the first high-speed printer for use with the UNIVAC computer

1953 Microwaves

Microwaves are used for the first time to transmit Community Antenna Television (CATV) signals when a broadcast is sent from a Denver, Colorado, station to a system in Casper, Wyoming

1953 Commercial Color TV

Commercial color television begins in the United States with limited programming on CBS late in the year; by the end of the year, most major NBC broadcasts are in color; RCA, the owner of NBC, works with the U.S. National Television System Committee (NTSC) to develop a so-called compatible color television system that allows black-and-white televisions to receive the color transmissions; CBS abandons its incompatible system in favor of the compatible NBC design

1953 IBM 650

IBM introduces the IBM 650 computer, based on the IBM 701 and called the Magnetic Drum Calculator; IBM sells 1,500 of these production-line computers, which feature a memory of 1,000 words, each using 10-bytes of memory, before canceling production in 1969

1953 Microwave Permit

The Federal Communications Commission (FCC) grants the first permit allowing a common carrier to use microwaves in the transmission of cable signals

1953 Memory Test

Kenneth Olsen builds a computer using Jay Forrester’s ferrite-core memory storage device; the Memory Test computer is used by the U.S. Air Force to perform SAGE (Semi Automatic Ground Environment) operations

1953-4 Cable-powered Amplifiers

C-Cor Electronics develops amplifiers that are cable-powered and messenger-mounted for the cable industry

1954 Split Broadband Amplifiers

Cable system operators are able to offer more channels when split broadband amplifiers are developed by the Blonder-Tongue company; this enables one channel to be used for carrying low VHF and high VHF signals simultaneously

1954 Silicon Transistor

The first pocket transistor radio is introduced by Gordon Teal at Texas Instruments; the transistor in this radio is made of silicon and is cheaper to make than the germanium-based transistors already being used

1954 UNIVAC 1103A

The UNIVAC 1103A is the first commercially available computer to use a ferrite core memory; data is processed 50 times faster than with the UNIVAC I released in 1951

1954 Programming Languages

John Backus of Philadelphia, Pennsylvania, publishes a report, *Specifications for the IBM Mathematical FORmula TRANslating System - FORTRAN,* initiating the development of true programming languages

1954 Uniprinter

Earl Masterson designs a line printer, the Uniprinter, for use with computers; it prints 600 lines per minute

1955 Fiber Optics

Scientist Narinder S. Kapany of India discovers that an insulated glass fiber can conduct light over long distances; this leads him to develop fiber optics

1955 SABRE

American Airlines implements use of the Semi-Automatic Business Related Environment (SABRE) for automating passenger reservations; IBM has connected 1,200 typewriters in the system, making it the first large network to be linked to a database; more advanced versions of the SABRE system are still in use today

1955 TX.O Terminal

Jack Gilmore completes the TX.O, the predecessor of the modern video terminal; his device is a human-machine interface using a cathode ray tube for the picture display and an optical pen, flexowriter, and function keys for giving commands

1955 Transistorized Computer

Bell Telephone builds the first computer to use transistors instead of electron tubes for data processing

1955 Transistor Calculator

IBM's first transistor calculator is introduced, using only 2,200 small transistors instead of the 1,200 bulky vacuum tubes that would otherwise be required

1955 FCC

The first major congressional investigation into the effects of television on juvenile delinquency ends, calling for the Federal Communications Commission (FCC) to monitor and censor programs and for stronger rules and regulations for the National Association of Broadcasters (NAB)

1956 Videotape Recorder

Ampex brings its first videotape recorder to market, five years after seeing a demonstration of the magnetic tape videotape recorder (VTR) developed by Armour Research

1956 Ferrite Core Memory

Jay Forrester is issued a patent for his ferrite core memory Whirlwind computer

1956 Transatlantic Telephone Cable

The first transatlantic telephone cable begins operation on September 25, linking Scotland with Newfoundland with submerged repeaters; before this time, short-wave radio telephones were used when making telephone calls between the United States and Europe

1956 FORTRAN I

John Backus of Philadelphia, Pennsylvania, and a team at IBM complete the design of FORTRAN I, commonly recognized as the first computer programming language; previously, computer programs could only be installed using machine language

1956 Computer Chess

Stanislaw Ulam and P. Stein program a computer to play a modified form of chess on a board with six squares on a side (normal chess uses eight squares on each side of the board); the program is called MANIAC I and is the first computer program to win a game played against a human

1956 Transistorized Computer

UNIVAC introduces the first second-generation computer that is commercially available; second-generation computers use transistors instead of vacuum tubes, reducing the size and cost of the computer and improving the reliability of data processing

1956 RAMAC Memory

IBM introduces the Model 305 Business Computer, capable of storing and accessing 20 megabytes of data on four hard disks; the storage method, called RAMAC (random access method of accounting and control), uses indexes to locate information on each disk

1956 Artificial Intelligence

John McCarthy coins the term artificial intelligence at a conference at Dartmouth College

1956-7 Solid-state Amplifiers

Henry Abajian develops solid state amplifiers while working at Westbury Electronics, creating a new state-of-the-art level of technology in cable television

1957 General Problem Solver

Allen Newell, J. C. Shaw, and Herbert Simon derive the General Problem Solver from the Logic Theorist; the General Problem Solver uses means-end analysis to solve problems and is an early form of artificial intelligence

1957 Artificial Intelligence Dept.

John McCarthy and Marvin Minsky found the Artificial Intelligence Department at the Massachusetts Institute of Technology

1957 Portable Electric Typewriter

Smith-Corona markets a portable electric typewriter that weighs more than its manual predecessors, tipping the scales at 18.3 pounds (8.3 kilograms)

1957 Plumbicon Color Camera

Philips introduces the Plumbicon color television camera

1957 Pay-TV

The first large-scale test of pay-TV begins in Bartlesville, Oklahoma

1957 Fairchild Semiconductor

Fairchild Semiconductor is founded by Gordon Moore, Robert Noyce, and others who leave Shockley Semiconductor Laboratory after William Shockley refuses to allow them to pursue research into silicon transistors

1957 Schickard Calculator

Designs are discovered for a calculator that was to have been built by Wilhelm Schickard for Johannes Kepler in 1623; Schickard’s machine is the earliest mechanical calculator believed to have been built, preceding Blaise Pascal’s adding machine by nearly 20 years

1958 Cable Regulation

The Federal Communications Commission (FCC) concludes that regulating cable television is beyond its authority because cablecasting differs from broadcasting in several significant areas

1958 Stereo Records

Stereo records become commercially available, with two tracks of sound recorded on each groove of a record; such recording is possible because both sides of the groove are used, one side for each sound channel; Duke Ellington experimented with stereo recording at least two decades earlier, but his results fell short of providing stereo sound and were released as monaural recordings

1958 Modem Dataphone

Bell introduces the Modem dataphone to transmit binary data over telephone lines; the term modem is derived from the fact that the device modulates and demodulates signals

1958 Computer Chess

Alex Bernstein and Michael Roberts develop a chess program that plays like a fair amateur and operates on an IBM 704 computer

1958 BIZMAC

RCA launches the BIZMAC computer, which stores and processes large databases of information by accessing 200 magnetic tapes connected via a network of smaller computers

1958 Integrated Circuit

Working separately, Jack St. Clair Kilby of Texas Instruments and Robert Noyce of Fairchild Semiconductor Corporation invent the integrated circuit, or chip; the device carries multiple electronic components on a single silicon chip and in a few years becomes an integral component in computers

1958 Stereophonic Radio

The British Broadcasting Corporation transmits stereophonic radio

1958 NEC 1101/1102

In Japan, NEC builds the first electronic computers, the NEC 1101 and 1102

1958 Supercomputer

Seymour Cray of Chippewa Falls, Wisconsin, builds the first supercomputer to be fully transistorized

1959 Helical Scan Video Recorder

Toshiba introduces the first helical scan video recorder

1959 COBOL

Grace Murray Hopper of New York City, one of the first programmers of the Mark I computer, develops the COBOL (Common Business Oriented Language) programming language for use in business programming

1959 LISP

John McCarthy finishes the initial design of LISP (List Processing), a programming language created for writing artificial intelligence applications

1959 Silicon Insulation

Jean Hoerni, working at Fairchild Semiconductor, produces a flat transistor that insulates the junctions with silicon; this soon becomes the primary method of insulating integrated circuits

1959 Transistorized Computer

Several manufacturers of electronic components introduce versions of the transistorized computer; included are the IBM 7090, IBM 1401, IBM 1620, NCR (National Cash Register) 304, and the RCA 501

1959-65 Cable Industry

The cable industry undergoes a period of rapid growth as Multiple System Operators (MSOs), cable operators with more than one cable system, expand their existing operations and buy additional franchises and cable systems

1960 Removable Memory

Removable computer memory disks first appear

1960 Interactive Cable TV

Key TV, the first serious attempt to predict the future of interactive cable television, is demonstrated at the National Cable Television Association convention in Miami, Florida

1960 Echo Satellite

Electrical engineer John Robinson Pierce of Des Moines, Iowa, working at Bell Laboratories, helps design and launch Echo, the first passive communications satellite

1960 ALGOL

European and American computer scientists meeting in Paris agree on a set of standards for the programming language ALGOL (ALGOrithmic Language); the language is based on plans put forward at a similar conference in held in Zurich in 1958; European programmers show great interest in ALGOL, but American programmers continue to prefer COBOL

1960 Packet Switching

Paul Baran of the Rand Corporation develops packet switching as a way of exchanging data between computers; packet switching uses many small bundles of information for each interchange, rather than sending data in one large block; this system allows damaged or missing packets of information to be retransmitted

1960 LARC

Remington Rand, manufacturer of the UNIVAC computer, finishes building the Livermore Advanced Research Computer (LARC) for Lawrence Livermore Laboratories; the machine is the first large scientific computer to use transistors, featuring 60,000 of them

1960 PDP-1

Led by Ken Olsen, Digital Equipment Corporation introduces the PDP-1 computer; with a maximum memory of 26,000 bytes, this state of the art machine is the first commercial computer with both a keyboard and a monitor to show what the user has entered; its size and configuration are predecessors of the minicomputer design

1960 Neural Network

Working at Cornell University, Frank Rosenblatt completes the Perceptron computer; using a neural network to simulate human thought processes, the Perceptron is the first computer that can learn new skills through trial and error

1961 MAC

John McCarthy introduces the use of time-sharing the MAC (Multiple Access Computer), allowing several operators to use a computer simultaneously

1961 Selectric Typewriter

IBM introduces the Selectric typewriter; the machine prints characters on paper with a rotating ball controlling the movement of letters inside the machine while the carriage remains fixed

1961 Stereophonic Radio

In the United States, FM radio stations air the first stereophonic broadcasts

1961 IBM 7030 Stretch

IBM completes the 7030 computer for Los Alamos Laboratories; nicknamed Stretch, it contains 169,100 transistors and is expected to be 100 times faster than the IBM 704 mainframe; the computer fails to meet this expectation, only operating at about 30 times the speed of the 704

1962 Telstar

Telstar, the first non-government active communications satellite, is launched on July 10 by AT&T; it relays the first transatlantic television pictures, although each transmission is only about 20 minutes long because that is how long the ground stations in England and Maine are simultaneously under the satellite

1962 Josephson Effect

Welsh physicist Brian David Josephson discovers the principle of tunneling between superconductors; the DC Josephson effect, as it is known, occurs when a supercurrent flows between two superconductors that are in close proximity to each other but separated by a thin oxide barrier; this movement of current has been used in many devices, including the SQUID, a very sensitive magnetometer

1962 Semiconductor Laser Activity

D. N. Nasledov observes laser activity by a semiconductor happening when infrared light is emitted by a gallium arsenide diode

1962 Aluminum Shielding

The technical quality of transmissions of individual cable channels is greatly improved when foam dialectric distribution cables are shielded with aluminum

1962 Thin-film Transistor

Working at RCA, Paul K. Weimer invents the thin-film transistor

1962 Audio Cassette

Philips introduces the compact audio cassette for recording sound on magnetic tape

1963 Natural-language Parsing

Artificial intelligence researchers note similarities between human and computer languages and attempt to design a computer that will break natural-language sentences into chunks of computer data; this process, called parsing, works by accepting text in a natural (human) language (such as English), analyzing the sentence structure, and translating the individual words or phrases into instructions the computer can follow; Susumo Kuno's parsing system illustrates the syntactic and semantic ambiguity of the English language when it is tested on the sentence Time flies like an arrow, in which *time, flies,* and *arrow* can all have multiple interpretations

1963 *Steps Towards Artificial Intelligence*

Marvin Minsky publishes his influential work titled *Steps Towards Artificial Intelligence*

1963 Instant Color Film

Self-developing color photography, also called instant color film, is introduced by the Polaroid Land Company; Elkin R. Blout of New York City heads the Polaroid Land research team that develops the process, although Howard G. Rogers of Houghton, Michigan, receives sole credit for creating the basic system

1963 Fuzzy Logic

Lotfi Zadeh of Baku, Russia, begins researching fuzzy logic at the University of California at Berkeley; fuzzy logic is a system in which problem-solving computer operations can produce results beyond strictly *true* or *false*, including *probably true, possibly true, possibly false,* and *probably false*; the first application for fuzzy logic systems is found 25 years later, when the subway system in Japan is equipped with computers capable of reaching any of this wider range of answers

1963 IMP Satellite

The National Aeronautics and Space Administration (NASA) launches the IMP satellite, the first to use integrated circuits

1963 Semiconductors

Semiconductor diodes using electron tunneling become commercially available

1963 Videodisk Camera

D. Gregg of the Stanford Research Institute and 3M invents a videodisk camera capable of storing images for several minutes

1964 ASCII

The American Standard Association adopts ASCII (American Standard Code for Information Interchange) as the standard text format in computer communications; ASCII only requires seven bits to allow the transmission of 128 different characters, and is accepted by the International Standard Organization two years later

1964 Arpanet

The Advanced Research Project Agency (ARPA) is established by the U.S. Department of Defense to develop Arpanet, a computer network that uses packet switching for communication and carrying data among various types of computers; Arpanet becomes operational five years later and eventually leads the way to the Internet

1964 Intelsat

The International Telecommunications Satellite Organization (Intelsat) is organized by the United States and 11 other countries with the goal of developing a global commercial telecommunications satellite system

1964 CDC 6600

Control Data Corporation introduces the CDC 6600 supercomputer, designed by Seymour Cray; this is frequently acknowledged as the first commercially successful supercomputer, in part because it features a speed of 9 megaflops (9 million multiplications per second)

1964 IBM 360

IBM introduces the 360 computer, designed by Gene Amdahl; it is compatible with numerous peripherals and is a commercial success; the 360 uses integrated circuits exclusively and marks the beginning of the third generation of computers

1964 Syncom 3 Satellite

The geostationary Syncom 3 satellite, based on Arthur C. Clarke's idea of geosynchronous satellite orbit, relays the first continuous television transmissions

1964 Moore’s Law

Gordon Moore, a founder of Fairchild Semiconductor Corporation, predicts that integrated circuits will double in complexity each year; this prediction, known as Moore’s Law, proves to be true for decades to come

1964 Commercial Integrated Circuit

Zenith uses an integrated circuit in a hearing aid; using an integrated amplifier that is also featured in the National Aeronautics and Space Administration's (NASA's) IMP satellite, the hearing aid is the first commercial product to incorporate such a device

1965 Electronic Telephone Exchange

In New Jersey, the first electronic telephone exchange is installed

1965 Solid State Technology

The cable TV industry sees the use of solid state technology in amplifiers and headend equipment become widespread

1965 Miniature TVs

Miniature transistorized televisions are introduced in Japan, but the devices have poor screen resolution

1965 Intelsat 1

The Early Bird satellite (Intelsat 1) is the first commercial telecommunications satellite that Intelsat places on a geostationary orbit; it can relay 240 telephone signals simultaneously and allows uninterrupted television broadcasts between the United States and Europe

1965 BASIC

John Kemeny and Thomas Kurtz develop a computer language for novice programmers called Beginners All-purpose Symbolic Instruction Code (BASIC); it becomes popular with owners of personal computers, although most commercially available personal computer programs are programmed in more sophisticated languages

1965 ELIZA

Joseph Weizenbaum at the Massachusetts Institute of Technology develops a computer program called ELIZA to study natural language communication between humans and machines; it carries on conversations with humans by asking users about their psychological problems

1965 Molniya

The Soviet Union launches Molniya, its first domestic communications satellite

1965 ILLIAC IV

The Burroughs Corporation develops the ILLIAC IV (Illinois Automatic Computer) massively parallel computer, designed by a research team led by Dan Slotnick; massively parallel computers do not use von Neumann architecture; the ILLIAC IV uses 64 identical scalar computers operating in conjunction with one another; massively parallel computers will later use microprocessors instead of separate computers

1965 PDP-8

Digital Equipment Corporation (DEC) introduces the first minicomputer, the PDP-8 (Programmed Data Processor); compared to mainframe computers, minicomputers are easy to operate and inexpensive at $18,000; the PDP-8 uses 4 kilobites of ferrite-core memory; its introduction marks the beginning of widespread computer use in business and education

1965 MSI

Designers introduce computer chips with 1,000 components per square centimeter; this level of density is called middle scale integration (MSI)

1965 Portable Video Recorder

Sony introduces the first portable video recorder

1966 Solid State Calculator

Texas Instruments introduces the first solid state, hand-held calculator; solid-state devices are characterized by the use of transistors and chips

1966 Cable Regulation

The Federal Communications Commission (FCC) begins regulating cable television systems

1966 Fiber Optics

Charles Kao and Georges Hockham, working at Standard Telecommunications Laboratories in England, demonstrate that fibers of very pure glass can be used to replace traditional copper wire and electric currents when transmitting data in light waves over long distances; this demonstration proves that fiber optic technology is in fact a viable method of data transmission

1966 Carterfone

John Van Green of Carter Electronics introduces the Carterfone, a portable modem and acoustic coupler designed to transmit digital data over telephone lines

1966 Set-top Box

Ronald Mandell and George Brownstein demonstrate the dual heterodyne set-top converter box, which allows televisions to receive more than twelve channels from cable networks

1966 CARS License

The Federal Communications Commission (FCC) grants the Santa Maria Valley (California) cable TV system the first Community Antenna Relay Service (CARS) license

1967 Fairness Doctrine

The Federal Communications Commission (FCC) announces that anti-smoking ads are needed to balance cigarette ads on television; this is the first commercial application of the Fairness Doctrine

1967 Dolby

Ray Milton Dolby of Portland, Oregon, finds a way to reduce audible background sound in recordings by lowering the volume of high frequency hissing; Dolby sound becomes widely used in motion picture audio and commercial sound-playback devices, such as cassette tape players

1967 Cordless Telephones

Battery-operated cordless telephones are introduced

1967 Logo

Seymour Papert and his associates at the Massachusetts Institute of Technology begin working on Logo, a programming language designed for educational use that will be widely used by children; an important characteristic of Logo is turtle graphics, which allow the programmer to instruct the turtle (an elongated triangle) to draw lines in any one of eight colors as it moves a specific distance in a particular direction; Logo is based largely on the LISP programming language and accepts very simple word-based commands such as right 45 degrees to indicate that the turtle should turn 45 degrees to the right (clockwise) on the screen

1967 Bubble Memory

Bell Laboratories introduces bubble memory, developed by A. H. Bobeck; bubble memory is a form of temporary memory that retains information without a constant source of power; the storage method works by holding data in numerous bubbles contained in a thin film

1967 Software

IBM announces that it will no longer sell software and hardware in a single package, a move that marks the beginning of explosive growth in the then-fledgling software industry

1967 Direct Dialing

A three-month trial of overseas direct dialing from New York to London and Paris begins on March 1; for the experiment, 80 New York customers have their phone lines modified

1967 Photocomposition

Photocomposition machines with cathode ray tubes are introduced by Hell Digiset and RCA Videocom

1967 Computer Networks

Olof Sšderblom introduces the concept of connecting computers in a computer network by a closed loop system rather than a centralized system; IBM uses this concept in designing its networked computer systems

1968 *Semantic Information Processing*

Marvin Minsky has *Semantic Information Processing* published; this seminal work is a collection of research papers written by Minsky and his students in their work developing artificial intelligence

1968 *2001: A Space Odyssey*

An intelligent computer named HAL that sees, hears, reasons, and speaks like a human is featured in the Stanley Kubrick film *2001: A Space Odyssey* by Stanley Kubrick (based on Arthur C. Clarke's novel)

1968 Fortnightly Decision

Cable television operators win a major victory when the U.S. Supreme Court rules in Fornightly Corp. *vs.* United Artists that cable operators do not have to pay copyright fees according to the Copyright Act of 1909

1968 Cable Regulation

The U.S. Supreme Court rules that the Federal Communications Commission is responsible for regulating cable television, even though cable does not fall under the technical definition of broadcasting

1968 Mouse

Douglas Engelbart of Portland, Oregon, introduces the computer mouse, a device that allows the user to direct the cursor (pointer) on a computer monitor and click a button to issue simple commands; later, the mouse becomes widespread in the computer industry after being used by Apple in the Lisa and Macintosh computers

1968 CDC 7600

Seymour Cray of Chippewa Falls, Wisconsin, designs the CDC 7600 supercomputer for Control Data Corporation; the 7600 is the second supercomputer that becomes a commercial success, the first having been the CDC 6600 of 1964; operating at a speed of 40 megaflops (40 million floating point operations per second), the 7600 is the most powerful computer available until Seymour Cray introduces the Cray supercomputer in 1976

1968 B2500/B3500

The Burroughs Corporation develops two computers using integrated circuits, the B2500 and B3500, for commercial production

1968 Intel

Gordon Moore and Robert Noyce leave Fairchild Semiconductor and found Intel Corporation, a manufacturer of integrated circuits

1968 Carterfone Decision

In the Carterfone decision, the Federal Communications Commission (FCC) rules that equipment manufactured by companies other than Bell may be used on AT&T telephone lines; previously, the Bell companies disconnected telephone equipment manufactured by other companies, sometimes going so far as to totally disconnect subscribers who used such devices; this ruling marks the beginning of competition in the U.S. telephone industry, eventually leading to the breakup of the Bell system

1969 RS-232-C Standard

The RS-232-C standard is introduced for the transmission of data between computers and peripheral accessories (such as modems)

1969 ATMs

Some U.S. banks begin installing automated teller machines (ATMs), but the machines are not networked; this limitation requires the consumer to use the ATM at his/her primary banking location

1969 SCTE

The cable television industry founds the Society of Cable Television Engineers (SCTE) to provide training to employees performing technical duties

1969 Red Lion Decision

In the Red Lion decision, the U.S. Supreme Court upholds the legality of the Federal Communications Commission's (FCC's) Fairness Doctrine; the court rules that television viewers have the right to a diverse array of opinions and that the need for different perspectives is more important than the right of broadcasters to endorse a specific viewpoint

1970's Artificial Intelligence

Bruce Buchanan and Edward Feigenbaum of Stanford University begin to explore knowledge engineering, the study of the relationship between intelligent behavior in humans and artificial intelligence research in computing

1970 Memory Chip

Intel earns $9 million in first-year sales of a computer memory chip that stores up to 1,024 bits of data and makes ferrite core memory obsolete

1970 Floppy Disk

The floppy disk first appears as a way of storing computer data

1970 Daisy Wheel Printer

The daisy wheel printer is developed for use in conjunction with computers; the machine uses a spoked metal wheel with letters on the tips of the spokes that strike an ink ribbon to print

1970 UNIX

Kenneth Thompson and Dennis Ritchie develop UNIX at Bell Labs; UNIX becomes the standard operating system for multi-tasking on computers of small and medium size

1970 PARC

Xerox establishes the Palo Alto Research Center (PARC) at Stanford University; the center researches noncommercial computer applications, and work done there leads to the development of the Ethernet computer networking architecture and the use of icons as graphical representations of computer operations that can be manipulated by the user; for example, an icon of a manila file folder may be used to represent a computer folder that contains files and programs; the user's ability to point-and-click on icons with a mouse makes computers easier to use

1970 Fiber Optics

Corning Glass produces the first long optical fiber for use in telecommunications

1970 LED

Charles A. Burrus of Shelby, North Carolina, invents the light-emitting diode (LED), a semiconductor that converts electrical energy to light without producing very much heat; LEDs are usually red and are used in numerous applications, such as on modems or computers to indicate that the device is running or as a flashing light on a smoke alarm with a low battery

1970 MOS

The metal-oxide semiconductor (MOS) is introduced by RCA; MOS technology is used to make integrated circuits smaller and less expensive to produce

1970 FCC

The Federal Communications Commission (FCC) implements a rule preventing one entity from owning any combination of radio and television stations in a single market; existing AM-FM-TV ownership combinations are not affected by this change in policy

1970 *The Wired Nation*

Ralph Lee Smith writes *The Wired Nation,* raising interest in the future of cable television services

1971 Dot-matrix Printer

Dot-matrix printers are introduced by US Centron for printing both graphic images and text characters; letters and pictures produced by dot-matrix printers vary in resolution depending on how densely the dots of ink are spaced on a page; low dot resolution produces images in which the individual dots are visible, while high ink density produces images that appear to be composed of uninterrupted ink (rather than dots)

1971 Pascal

Niklaus Wirth writes the Pascal programming language (named in honor of Blaise Pascal, inventor of the first calculator); Pascal, which works much like ALGOL does, becomes popular in home computer programming

1971 Speech Recognition

While working on his SUR (Speech Understanding Research) project, Raj Reddy develops a speech recognition software program called Hearsay at Carnegie Mellon University; the U.S. military funds Reddy’s work in an effort to develop computers that understand speech without the need for a keyboard and typewritten commands

1971 Intel 4004 Chip

Intel introduces the 4004 microprocessor; the silicon chip measures 7-mm x 7-mm and features 2,300 transistors and a processing rate of 4 bits at 60,000 cycles per second

1971 Pocketronic

Texas Instruments introduces the Pocketronic, the first pocket calculator; the machine weighs 2.5 pounds (1 kilogram), costs $150, and can only add, subtract, multiply, and divide

1971 TMS 1000 Chip

Gary Boone and Michael Cochran receive the first patent for a microprocessor; their TMS 1000 computer chip combines integrated circuits, memory, a central processor, and output circuits; it is used extensively in pocket calculators

1971 RISC

The development of RISC (Reduced Instruction Set Computer) microprocessor chips begins when John Cocke and coworkers at IBM recognize that computers can process data using only the simplest of instructions; RISC computer chips require fewer instructions in order to understand and process the same directions as regular microprocessors

1971 Cray Research

Supercomputer developer Seymour Cray leaves Control Data Corporation and founds Cray Research to specialize in designing and manufacturing vectorial supercomputers

1971 Cable Regulation

The Federal Communications Commission (FCC) assumes control of regulating paid services offered on cable television systems, preventing local authorities from regulating and profiting from such programming

1972 Laservision

Philips Corporation of the Netherlands introduces Laservision, a video recording system using lasers to inscribe data to disk; this method of recording influences both the home video recording and compact disk industries

1972 Digital TV

The British Broadcasting Corporation (BBC) introduces digital television

1972 *What Computers Can't Do*

Hubert Dreyfuss publishes *What Computers Can't Do*, a thesis in which he argues against symbol manipulation serving as the basis of artificial intelligence research

1972 Cable Regulation

The Federal Communications Commission (FCC) issues definitive rules for the regulation of cable television; as a result of these new rules, cable television services are restricted in the top 100 cable markets

1972 Interactive TV

Interactive cable television services become possible with the use of two-way cable lines connecting the cable operator and each individual home

1972 PROLOG

Alain Colmerauer develops the PROLOG programming language, which becomes popular in artificial intelligence programming

1972 C

Dennis Ritchie and Kenneth Thompson develop the C programming language at Bell Labs; C becomes enormously popular in software development

1972 VIP 100

The VIP 100 speech-recognition system, developed by Threshold Technologies, can recognize words in a limited vocabulary, but only if each word is individually enunciated

1972 SMALLTALK

Alan Kay introduces SMALLTALK, one of the first object-oriented programming (OOP) languages

1972 Computer Networks

Two computer networks are established to allow users all over the world to communicate with one another, one by Telenet Communications Corporation and the other by TYMNET

1972 Word Processing

Lexitron markets the first word processing system, which is quickly followed by a more successful product created by VYDEC Corporation; shortly thereafter, a word processing system that stores data on magnetic tape and uses an IBM Selectric typewriter as the printer is introduced by Wang Laboratories

1972 Intel 8008 Chip

The first 8-bit microprocessor chip, the 8008, is developed by Intel for use in the Mark-8 personal minicomputer

1972 Odyssey

Magnavox develops Odyssey, the first video game

1972 Pong

Nolan Bushnell, an American, invents Pong, a video game that uses a liquid crystal screen; the game is incredibly popular, and its success prompts Bushnell to found Atari

1973 Intel 8080 Chip

Intel develops the 8080 microprocessor chip to replace the 8008

1973 SMALLTALK

Alan Kay uses SMALLTALK software to develop the first office computer, incorporating the use of a mouse, icons, and graphics in its design

1973 Superconductors

Brian D. Josephson, Leo Esaki, and Ivar Giaever share the Nobel Prize in Physics for the work each has done in the development of voltage tunneling between superconductors

1973 Satellite Receiver

Scientific-Atlanta develops the first portable earth-based communications satellite receiver

1973 Atanasoff

John Vincent Atanasoff is attributed with the invention of the modern computer when the ENIAC patent is invalidated

1973 LSI

A 1-centimeter square computer chip that contains 10,000 components is developed; this level of component density is called large-scale integration (LSI)

1973 Electron Capture

Hans Dehmelt of Germany succeeds in capturing and holding a single electron for up to ten months with the help of Philip Ekstron and David Wineland, his assistants

1973 FCC

The Federal Communications Commission (FCC) approves the use of communications satellites for data transmission in the United States

1973 CATA

The Community Antenna Television Association (CATA) is organized to represent the interests of cable television system operators

1974 DBS

The ATS-6 satellite is used to offer direct-broadcast television service

1974 Westar I

Westar I, the first domestic communications satellite in the United States, is launched by Western Union; it is used to transmit telephone and television signals, and becomes so popular that Western Union begins urging its customers to conserve satellite circuit space by using modems as an alternate method of transmitting data

1974 Typewriter

The IBM Corporation introduces the Memory typewriter, a machine capable of storing up to 50 pages of type on magnetic tape and retyping the text at a speed of 150 words per minute

1974 HDTV

Panasonic introduces the first high-definition television system, featuring a high resolution provided by 1,125 scanning lines

1974 Fax Standard

The first international fax standard (the Group 1) is set with a transmission rate of one page sent every six minutes

1974 Computer Chess

Stockholm, Sweden, is the site of the first championship for chess-playing computers

1974 Programmable Calculator

Hewlett-Packard introduces the first programmable pocket calculator; the device allows the user to store data, including problem sets and answers

1974 Microcomputer

David Ahl of Digital Equipment Corporation (DEC) develops a microcomputer that incorporates a video display, keyboard, and central processing unit in one assembly; DEC shows no interest in manufacturing the machine

1974 DRAM Chip

A DRAM (dynamic random access memory) computer chip with 4 kilobits (4096 bits) of memory is introduced; personal computers provide the largest market for such chips

1974 LCD

Working at Westinghouse, T. Peter Brody and coworkers successfully use thin-film transistors to control liquid-crystal displays (LCDs); this allows smaller devices to be made using liquid-crystal displays, such as digital watches

1975 FCC

The Federal Communications Commission (FCC) restricts newspapers from owning radio stations that operate in the same market; existing same-market newspaper-radio ownership combinations are not immediately affected

1975 Satellite Transmission

Gerald Levin, working for Home Box Office (HBO), realizes that paid programming (such as HBO) can be distributed to a wider audience by using communications satellites to transmit signals; led by other pay-TV stations, the entire cable television industry begins using satellite distribution services, virtually eliminating regional signal transmission by microwave

1975 Ethernet

Xerox develops the Ethernet computer networking architecture for use at the Palo Alto Research Center (PARC), although its use eventually spreads to many local area networks (LANs); the system transfers packets of information (such as files or electronic mail) from one user to another; each packet has an electronic address that specifies the delivery location (much like an envelope in the U.S. mail system must have the destination clearly marked on the outside), and Ethernet moves the data through points in a circle until it finds the addressee, where it drops off the appropriate packet(s)

1975 Threshold 600

E.M.I.-Threshold Technology designs the Threshold 600, a voice-recognition computer system based on the work of Thomas B. Martins and R. B. Cox; its vocabulary includes 512 words, each of which requires one second to process

1975 Laser Printer

IBM introduces the laser printer, a faster printer than the ink-jet printer developed one year later; laser printers produce exceptionally clear print, compared by some to the clarity obtained by photocomposition techniques

1975 LCD

In Great Britain, liquid-crystal displays become available in pocket calculators and digital clocks

1975 Altair 8800

In the United States, Edward Roberts introduces the Altair 8800 personal computer; it has 256 bytes of memory and is marketed in a kit that the buyer must assemble

1975 Word Processor

Michael Shrayer develops the first word processor designed for use with a personal computer; it is called the Electric Pencil and operates on the Altair 8800

1975 Microcomputer

IBM designs a microcomputer but does not market it on the assumption there will be no interest in microcomputers

1975 Zilog

Zilog Corporation is founded by engineers from several electronics manufacturers with the goal of manufacturing computer microprocessor chips

1975 CTAM

The Cable Television Administration and Marketing Society (CTAM) is organized to coordinate the needs and interests of cable system operators

1976 Superminicomputers

Superminicomputers are developed by Perkin-Elmer and Gould SEL; the machines are smaller than supercomputers, filling the space in a closet rather than taking up an entire room

1976 Copyright Act

The U.S. Congress passes a new copyright bill to replace the 1909 Copyright Act; the new law addresses copyright issues surrounding cable television and requires that cable operators carrying broadcast television signals pay fees to the non-cable broadcasters

1976 Fiber Optics

Cable television operators begin using fiber optic trunk line distribution to transmit signals a longer distance; fiber optic lines require fewer amplifiers, improve picture quality, and reduce interference of signals

1976 VHS

JVC develops the VHS (video home system) videotape format, still in use as the most common form of home video recording and playback; this is the same format used in most videotapes currently available for rent or purchase

1976 CP/M

Gay Kildall develops CP/M (Control Program for Microcomputers) operating system

1976 Ink-jet Printer

IBM develops the ink-jet printer, a machine that prints by sending miniature drops of ink through a tube and then directing them onto a piece of paper in the appropriate pattern to create letters; the printing mechanism does not actually touch the paper, leading the machine to also be called the non-impact printer

1976 Memory Chip

A computer chip with 16 kilobytes (16,384 bits) of memory, later used in IBM's personal computers, becomes available

1976 Cray-1

Seymour Cray completes the Cray-1 supercomputer at Cray Research; it is the first supercomputer to use a vectorial architecture; the Cray-1 has a performance rating of 100 million floating point operations per second (MFLOPs) and uses 200,000 integrated circuits cooled by freon; the computer is built in a cylindrical shape to shorten the distance between components

1976 PENNARAMA

The Pennsylvania Learning Network (PENNARAMA) begins offering a distance education program using a statewide instructional and informational cable network paid for by the Pennsylvania Educational Communications System (PECS); Pennsylvania State University manages the network

1977 Fiber Optics

AT&T, Western Electric, the Bell System, and International Telephone & Telegraph (ITT) conduct fiber optic experiments in Georgia, Illinois, and England

1977 PCs

Personal computers with self-contained monitors and cassette tape data-storage systems are introduced by Tandy Corporation and Commodore Business Machines; other microcomputers of the time use television sets for the monitor

1977 Microsoft

Paul Allen and Bill Gates found Microsoft, a software manufacturer that quickly becomes a leader in the industry

1977 Apple II

Steven P. Jobs and Stephen Wozniak introduce the Apple II personal computer, the first preassembled personal computer; it is the best-selling personal computer for several years, only declining in popularity after the introduction of the IBM Personal Computer (PC) a few years later

1977 Star 8010

Xerox develops the Star 8010 office computer; the design is based on the machine built by Alan Kay a few years earlier using SMALLTALK

1977 ATMs

Networked automatic teller machines (ATMs) are introduced by a Denver, Colorado-based credit card processor; previously, ATM users could only use the machine located at his/her primary banking location

1977 LAN

Datapoint develops the ARC local area network (LAN), the first small-scale computer network of its kind

1977 Superstation

The first superstation, WTCG of Atlanta, Georgia (now WTBS), begins operation; a superstation is a station that sends its signals to cable operators via a satellite or a land-based microwave system

1977 QUBE

Warner Cable introduces QUBE, the first interactive television system, to its subscribers in Columbus, Ohio

1978 Metal-particle Audio Tape

3M introduces pure metal-particle audio tape to improve high-frequency response

1978 PC Disk Drive

Apple develops the first disk drive designed for personal computers

1978 Wordstar

John Barnaby develops the Wordstar word processor for the CP/M (Control Program for Microcomputers) operating system; MicroPro markets the software and adapts it for DOS, and Wordstar is tremendously popular in the early 1980's; the program revolutionizes word processing, featuring on-screen line-by-line code programming that is awkward to use by today's standards

1978 TMC 0280 Chip

Texas Instruments (TI) develops the TMC 0280 speech synthesizer computer chip; the TMC 0280 forms the basis of the Speak & Spell educational toy for children when it is combined with two other TI chips, the TMC 0350 and the THC 0270

1978 Fiber Optics

The first telephone link in Europe to use fiber optic lines is built in England between Martlesham and Ipswich

1978 VAX

Digital Equipment Corporation (DEC) introduces virtual address extension (VAX) in a 32-bit computer; VAX lets the computer run programs that are larger than the capacity of its semiconductor memory, and VAX machines become widely used in scientific applications (using the VMS operating system)

1978 Intel 8086 Chip

Intel introduces the 8086 16-bit microprocessor; a slightly simplified version of this processor, the Intel 8088, is used when IBM markets its Personal Computer (PC)

1979 Videodisk

Philips and Sony introduce the videodisk, a machine that digitally records images and sound as tiny pitted marks on the disk surface

1979 Cellular Telephone Network

Tokyo is the site of the first cellular telephone network trials; Bell Labs uses 2,000 people to test a cellular telephone network in Chicago later in the year

1979 INMARSAT

The International Maritime Satellite Organization (INMARSAT) is founded to provide communication and navigation services to ships via satellite

1979 VisiCalc

The VisiCalc (Visible Calculator) spreadsheet software program is written by Daniel Bricklin, a computer scientist and accountant, and Robert Frankston, a programmer; VisiCalc has built-in calculating functions that allow the user to perform financial budgeting and analysis, as well as other business applications, without knowing how to program a computer; 800,000 copies are in use by 1985

1979 ADA

Jean Ichbiah and coworkers develop the ADA programming language (named for Ada Lovelace, an early computer programmer who helped explain Charles Babbage's Analytical Engine to the public); ADA is written after the Pentagon's High Order Language Working Group (HOLWG) studies the possibility of creating a standard programming language to replace the thousand or so languages currently in use by the U. S. Defense Department

1979 LCD

P. G. LeComber and coworkers at the University of Dundee (Australia) demonstrate that thin-film transistors used to control liquid-crystal displays can be built from amorphous silicon

1979 Digital Telephone Exchange

The first digital telephone exchange in Great Britain becomes operational, near Aberdeen, Scotland (at Glenkindie); electromechanical telephone exchanges continue to be used in Great Britain until 1990

1979 Motorola 68000 Chip

Motorola introduces the 68000 microprocessor chip, featuring 16 megabytes of memory capacity and a 24-bit capacity for reading data; it is used in the development of Apple's Macintosh computer

1979 MOSFET

Steven Hofstein uses metal oxide technology (MOFSET) to invent the field-effect transistor

1979 C-SPAN

C-SPAN begins covering Congressional proceedings live on television thanks to the sponsorship of cable television operators and the National Cable Television Association (NCTA); analysts have since called C-SPAN the most significant citizen education medium at the national level in recent history

1980 Set-top Box

Addressable set-top converter boxes allow cable television operators to determine which channels enter subscribers' homes, providing a sort of on/off switch to help regulate the distribution of television signals; this technology is especially useful in preventing adult-oriented material from entering homes where it is not wanted and makes pay-per-view programming possible

1980 DBS

COMSAT announces plans for an extensive direct broadcast satellite (DBS) system and begins a two-year drive for authorization of DBS programming

1980 Minitel

Minitel is launched in France, allowing telephone customers to use an in-home terminal to perform a number of functions via an on-line system

1980 dBase II

Wayne Ratliff develops dBase II, a database management software package based in part on the Vulcan I database program developed in the late 1960's for mainframe computers at the Jet Propulsion Laboratories; dBase II becomes the primary file maintenance system used in personal computers

1980 Barium Atom Astrid

Hans Dehmelt, working with scientists at the University of Heidelberg in Germany, successfully photographs a single barium atom (which the scientists name Astrid)

1980 Fax Standard

The current international fax standard (Group 3) is set, allowing the transmission of facsimile messages at the rate of one page per minute

1980 CDs

Sony, Philips, and Polygram propose technical standards for the manufacture of compact disks (CDs); these standards are necessary if CDs are to become a commercial success like records and cassette tapes, which are already produced according to standard guidelines

1981 FCC

Mark Fowler becomes Chairman of the Federal Communications Commission (FCC) and immediately implements a strong policy of deregulating the telecommunications industry

1981 Pocket-sized TV

Sinclair Radionics introduces the first pocket-sized television

1981 MS-DOS

Microsoft develops MS-DOS (Microsoft Disk Operating System, originally called PC-DOS) for use in the IBM Personal Computer (PC)

1981 IBM PC

The IBM Personal Computer (PC) is introduced, operating on a disk-operating system (DOS) platform; DOS becomes the standard operational architecture of the personal computer industry

1981 Lotus 1-2-3

Mitch Kapor develops the Lotus 1-2-3 spreadsheet program for the IBM Personal Computer (PC) and compatible computers; Lotus 1-2-3 adds bar graphs, pie charts, and other graphic representations to the calculating abilities of existing spreadsheet software

1981 CD Standard

Technical standards proposed by Sony, Philips, and Polygram for compact disc (CD) production are accepted worldwide; this makes commercial CD production commercially viable

1981 Portable Computer

Osborne manufactures the first comprehensive portable computer, which includes a disk drive, monitor, and central processing unit within a single casing; the computer is the size and weight of a packed suitcase

1981 64-bit Chip

Japanese computer chip manufacturers introduce 64-bit memory chips that immediately become the most desirable chips available

1981 CAB

The cable television industry creates the Cable Advertising Bureau (CAB) to address issues surrounding cable advertising

1982 PC Clone

Columbia Data Products introduces the first computer clone of the IBM Personal Computer (PC); such clones are compatible with the IBM PC, using the same software and frequently costing significantly less than the IBM product

1982 Portable PC Clone

Compaq Computer Corporation introduces two clones of the IBM Personal Computer (PC); one is designed for use at a desk and the other is the first portable PC clone

1982 CDs

Sony and Philips introduce compact disc (CD) players; the CD is a 4.8-inch-diameter plastic disc that contains sound or other data recorded in tiny pits on its surface; the recorded information is then read by a laser and replayed; Billy Joel's *52nd Street* is the first CD

1982 Postscript DTP

Postscript desktop publishing (DTP) software is introduced to computing; DTP displays text and a wide variety of graphic elements (including charts, diagrams or illustrations, and photographs) on the screen and allows the user to manipulate the layout of every page in a document; items on each page can be rearranged and viewed on-screen, eliminating the need to print out each page in order to evaluate its appearance; DTP allows the user to produce high-quality documents without investing in expensive printing and layout design equipment, as printing is done on laser printers and typesetting machines

1982 Voice Recognition

Martine Kempf writes a voice recognition software package that eventually leads to the development of the Katalvox voice-operated control device used in wheelchairs and microsurgery magnifiers

1982 AT&T Breakup

Issuing the Modified Final Judgment, Judge Harold Greene of the District of Columbia Federal Court determines that AT&T has violated the Sherman Anti-Trust Act by monopolizing telephone service in the United States; AT&T is ordered to separate itself from 22 Bell System telephone companies; AT&T is thereby restricted to offering only long-distance telephone services, while the so-called Baby Bells or regional Bell operating companies (RBOCs) become the primary providers of local telephone services; Judge Greene's order goes into effect on January 1, 1984

1982 Cray X-MP

Steve Chen finishes designing the Cray X-MP (extended multi-processor) parallel architecture computer; the machine uses two linked Cray-1 supercomputers and operates at three times the speed of a single Cray-1

1983 MMDS

The Federal Communications Commission (FCC) approves multichannel multipoint distribution service (MMDS), or wireless cable, television service; MMDS delivers up to 28 channels of cable programming without using cables to transmit the signals; channels are delivered to subscribers by relaying the signal through microwave radio transmission services

1983 Non-digital Cellular Telephone

The first non-digital U.S. cellular telephone system begins service; cellular telephones quickly become popular, and 312 cellular systems are established in 205 U.S. cities within the next four years

1983 Apple PCs

Apple introduces the Lisa, the first personal computer with a mouse and pull-down menus; a computer mouse is a small device that is moved over a hard surface on the desktop; this motion in turn coordinates the motion of a cursor on-screen, and pressing a button on the mouse directs the computer to execute commands (determined by which on-screen icon the cursor is centered on); Lisa is expensive and relatively unsophisticated, but it leads to Apple's later use of the same features in the highly popular Macintosh personal computer

1983 Computer Virus

While researching computer security, Fred Cohen writes a program designed to replicate copies of itself inside other programs; he coins the term computer virus to describe programs of this type; viruses spread to computers via networks and shared disks, and most are designed to wreak havoc on a computer either as a joke or as a serious attempt to damage a computer system

1983 IBM PC-XT

IBM introduces the Personal Computer-XT (PC-XT), the first personal computer to feature a self-contained hard disk drive; hard drives, as they are called, store information when the computer is turned off, eliminating the need to load a software program from floppy disks each time the program is to be run; the PC-XT stores up to 10 megabytes of data and uses an advanced disk operating system, DOS 2.0, to create directories, subdirectories, and an unlimited number of files for organizing the materials contained on the hard drive

1983 Parallel Processing

Immos, a British computer manufacturer, introduces the transputer parallel processing computer; by using multiple processors simultaneously, the computer can solve problems much more quickly than can a single processor operating alone

1983 Josephson Junction

M. Gurvitch, M. A. Washington, and H. A. Huggins develop a Josephson junction designed for use in large-scale integrated circuits; the junction separates two niobium electrodes with an aluminum-oxide barrier

1984 Cable Deregulation

The Federal Communications Commission (FCC) uses existing radio regulations to determine a course of television deregulation; individual television operators are now allowed to determine the number of commercials that will be broadcast each hour, whether or not infomercials (program-length commercials) will be carried, and what forms of non-entertainment-oriented programming will be offered, if any

1984 Cable Communications Policy Act

The U.S. Congress passes the Cable Communications Policy Act of 1984, which regulates rate-setting, equal employment opportunity requirements, franchise renewal issues, and other areas of concern to the cable industry

1984 Optical Disc Storage

Optical disc computer data storage systems are introduced

1984 MacPaint

Working for Apple, Bill Atkinson writes the MacPaint graphic-creation software program for the Macintosh; the program lets the user draw pictures on screen; those pictures can then be incorporated into other software packages, such as desktop publishing programs

1984 Computer Virus

A study of computer viruses is done at the Technical University of Berlin; the results of the study become the first information available on such destructive virus programs as Friday 13, Holland Girl, Trojan Horse, and Christmas Tree

1984 Apple Macintosh

Apple develops the Macintosh personal computer, featuring a mouse and pull-down menu system developed earlier for the unsuccessful Lisa personal computer

1984 IBM PC-AT

IBM introduces the PC-AT (Advanced Technology) personal computer; it is the first PC to have an expandable memory, something that is achieved by putting a new chip into the computer when existing memory is determined to be insufficient

1985 Media Laboratory

Jerome Wiesner and Nicholas Negroponte found the Media Laboratory at Massachusetts Institute of Technology with the goal of researching media-related applications in computer science, sociology, and artificial intelligence

1985 MacWrite

Working at Apple Computer, Ed Rudder, R. Wigginton, and Don Breuner develop the MacWrite word processor for the Macintosh personal computer

1985 Windows

Microsoft develops Windows for the IBM Personal Computer (PC) and compatible machines; Windows allows the user to point-and-click (with a computer mouse) to indicate that the computer should perform an operation; the Apple Macintosh first made this type of graphical user interface (GUI) popular

1985 PageMaker

Paul Brainard develops the PageMaker desktop publishing software for the personal computer; introduced by Aldus, PageMaker enjoys great success first on the Apple Macintosh and later on the IBM Personal Computer (PC) and compatibles

1985 LCD TV

In Japan, Seiko-Epson manufactures a liquid-crystal display (LCD) two-inch television screen using polycrystalline silicon

1985 Fiber Optics

AT&T Bell Labs uses an optical fiber to transmit an amount of data equivalent to 300,000 concurrent telephone conversations

1985 Cray 2

Cray Research introduces the Cray 2 supercomputer, a machine with 10 times the processing capacity of the Cray 1; it has a 2-billion byte memory and uses four processors that give it a performance rating of 1 billion floating-point operations per second (FLOPS); as an added bonus, the Cray 2 is very small when compared to earlier Cray supercomputers, which usually occupied an entire room

1985 NSF

The U.S. National Science Foundation (NSF) establishes five supercomputing centers nationwide; the centers are located in San Diego, California; Pittsburgh, Pennsylvania; Princeton, New Jersey; Ithaca, New York; and Champaign-Urbana, Illinois; the Illinois site is known as the National Center for Supercomputing Applications (NCSA)

1985 Fuzzy Logic

Working at AT&T Bell Labs, Masaki Togai and Hiroyuki Watanabe develop a computer chip that uses fuzzy logic to make decisions; fuzzy logic expands the range of computer responses or conclusions from *true* or *false* to include, *probably true, possibly true, possibly false,* and *probably false*

1985 FCC

The Federal Communications Commission (FCC) changes ownership rules, increasing the number of stations that one entity can own from 21 stations (7 AM radio, 7 FM radio, and 7 television) to 36 stations (12 of each format)

1986 Cable Scrambling

HBO is the first paid cable television channel to scramble its signals in an effort to limit unauthorized signal reception in the home; many other pay-services later follow suit

1986 DAT

In Japan, the first digital audio tape (DAT) machines are demonstrated

1986 Subcarrier Signals

In Europe, FM radio stations begin transmitting digital data on the subcarrier signal of FM radio waves, effectively sending out two forms of data simultaneously on the same signal

1986 Neural Networks

Terry J. Sejnowski, working at the Johns Hopkins University in Baltimore, Maryland, develops a computer that uses neural networks to read textual data out loud without learning any rules of pronunciation; neural networks are a form of artificial intelligence designed to simulate the operating structure of a human brain; neural networks learn to recognize patterns (especially in spoken and written language) through task repetition

1986 DeskPro

Compaq Computer Corporation introduces the DeskPro computer, a 32-bit machine using the Intel 80386 chip to process data three times faster than the most advanced 16-bit personal computers

1986 Home Shopping

Home shopping networks begin using satellites to transmit shopping programs nationwide on cable television

1987 EuroPACE

EuroPACE is founded as a distance education provider in Europe; the organization uses satellite transmissions and electronic mail to train engineers, scientists, and college students

1987 Audio Clarity

Two systems are developed for eliminating background noise from audio recordings, one in the United States and the other in England; Sonic Solutions in San Francisco, California, digitally replaces background noise with an audio track of the same frequency as the sound immediately preceding the unwanted noise; the National Sound Archive in England improves the recording by replacing the noise with an identical section of audio taken from a higher-quality copy of the same recording

1987 Airplane Telephones

Japanese airlines introduce telephones on airplanes; satellites are used to relay the telephone signals

1987 Fling

Kodak introduces the Fling disposable camera, which requires that the user send the entire camera back to Kodak for processing; in a system remarkably like the one used for the first Kodak camera (1888), the user buys a new Fling in order to take more pictures

1987 Apple Dominance

Apple's Macintosh II and Macintosh SE are the fastest and most powerful personal computers commercially available

1987 IBM PS/2

IBM introduces the Personal System/2 line of personal computers; the machines use 3-1/2 inch floppy disk drives and hard drives and other improved graphic quality (including enhanced monitors), as well as an updated operating system that allows computers to be networked; the system uses a design called Micro Channel Architecture (MCA) which processes data much faster than existing computers; unfortunately, MCA is incompatible with the normal internal devices (such as expansion video and sound cards, memory boards, and extra disk drives) designed for personal computers, and owners of MCA machines must buy specially designed hardware that is frequently sold at higher prices than non-MCA products

1987 NASF

The Numerical Aerodynamic Simulation Facility (NASF) begins operating, performing calculations at speeds of up to 1.7 billion functions per second; the machine is an advanced supercomputer devoted to simulating real-world conditions

1987 S-SEED

Working at AT&T Bell Labs, David Miller invents the Symmetric Self-Electro-optic Effect Device (S-SEED); the device is exposed to radiation by a laser, causing a change in the S-SEED's reflectivity to light; it leads to development of the first optical computer

1987 Cray Y-MP

Cray Research introduces the Cray Y-MP supercomputer, the fastest machine Cray has ever produced

1987 Fairness Doctrine

The Federal Communications Commission (FCC) abolishes the Fairness Doctrine, declaring it unconstitutional

1987 FCC

A three-judge panel of the U.S. Court of Appeals orders the Federal Communications Commission (FCC) to stop requiring that cable television operators offer local broadcast television stations as a part of basic cable service packages, declaring that the First Amendment guarantees cable operators the right to choose which stations will be offered on any given cable system

1988 Fiber Optics

The first transatlantic fiber optic line is laid, capable of carrying 37,800 voice channels (such as telephone calls)

1988 Scriptel

The American company Scriptel develops a data-entry system that allows the user to write on a computer screen (rather than type in every piece of text that is to be entered into the computer's memory)

1988 Voice Recognition

Kai-Fu Lee, a graduate student at Carnegie Mellon University, shows that it is possible to design a voice-recognition computer system that will reply correctly to spoken words the majority of the time; such a machine does not need to be trained to identify individual voices

1988 Internet Virus

Robert T. Morris, Jr., a graduate student at Cornell University, is fined and expelled after secretly releasing a virus on the Internet computer network; although this is done as a prank, it spreads to more than 60,000 computers around the world and disables thousands of them for up to two days

1988 RISC

Motorola introduces a 32-bit line of RISC (reduced instruction set computing) microprocessors (the 88000 chip series); RISC chips require fewer instructions in order to understand and process the same directions as regular microprocessors, enabling them to operate much more quickly; RISC chips can perform up to 17 million functions per second

1988 EISA

Compaq Computer Corporation and Tandy Radio Shack lead a group of personal computer manufacturers in the development of the Extended Industry Standard Architecture (EISA) for computers using 32-bit advanced microprocessors (such as the Intel 80386 and 80486 chips); this standard is created in response to IBM's Micro Channel Architecture (MCA), used in its PS/2 computers

1988 NeXTstep

Steven P. Jobs introduces the NeXTstep computer workstation (developed at his new company, NeXT Computer, Inc.); the machine uses a graphics-based design (similar to the systems used in Macintosh computers and Windows software) and features an erasable optical storage disc with 256 megabytes of permanent memory and 8 megabytes of RAM (random access memory, a temporary memory that is erased when the computer is turned off)

1988 Transistor

AT&T develops a transistor that is activated by the energy contained in just a single electron; this transistor is more responsive than previous transistors and helps electronics manufacturers produce devices that require less energy to begin operation

1988 Parallel Processing

John L. Gustafson, Gary R. Montry, and Robert E. Benner develop a method for rewriting the problems given to parallel processor computing systems; the new method of writing problems increases the system's problem-solving speed by a factor of 1,000, far exceeding the expected limit of a 100-fold increase

1988 4-bit Microprocessor

Working at Fujitsu Laboratories in Japan, T. Kotani and coworkers develop a 4-bit microprocessor that incorporates Josephson junctions

1988 HDTV Standard

The Federal Communications Commission (FCC) decides that high definition television (HDTV) systems must work with existing receivers (television sets) and operate within the currently designated broadcast television frequency spectrum

1989 Portable Macintosh

Apple introduces the first portable Macintosh; personal computer users have awaited this event with much anticipation, as IBM and the IBM-clone computer makers have produced portable computers for years

1989 Computer Chess

The computer Deep Thought defeats chess player David Levy, a master of the game who had been beating computers in chess matches since 1968; however, Gary Kasparov, another chess master, wins a two-game chess match with Deep Thought on October 22

1989 HDTV

Japan begins broadcasting an analog high definition television (HDTV) signal on a daily basis; initial programming includes an hour-long program highlighting the Statue of Liberty and New York Harbor

1989 MITI

The Ministry of International Trade and Industry (MITI) in Japan founds the Laboratory for International Fuzzy Engineering Research; work done there helps find applications for fuzzy logic computer systems

1989 Videodiscs

Philips and Sony introduce videodiscs, compact discs (CDs) that contain video images (such as short movies or music videos) rather than audio recordings

1989 Cray Computer Corporation

Seymour Cray founds the Cray Computer Corporation (CCC), a spin-off of Cray Research; CCC starts developing the Cray 3 supercomputer with gallium arsenide chips, which provide faster processing than traditional silicon chips; Cray Research retains a 10% interest in CCC

1990 Cray Y-MP2E

Cray Research introduces the Y-MP2E supercomputer with an introductory price of $2.2 million; for the first time, supercomputers are affordable for smaller companies

1990 ISDN

ISDN (integrated services digital network) technology is used commercially for the first time; ISDN simultaneously transmits voice, video, still images, and other data on a single high-speed connection

1990 Color Fax

Facsimile (fax) machines that are capable of transmitting color images and text become commercially available

1990 Fiber Optics

The state of Iowa begins constructing a 2,800-mile (4,500 kilometer) fiber-optic network that will eventually connect all 99 counties statewide; the system is used to broadcast college courses, carry government communications among state agencies, link libraries, maintain voter registration records, and distribute lottery tickets; it takes three years to complete the $200 million endeavor

1990 All-Optical Chip

Alan Huang of Bell Labs leads a team of researchers and scientists in demonstrating the first all-optical computer processor; the device is programmed by a traditional electronic computer, and is about as powerful as an electronic chip that operates a dishwasher

1990 Motorola 68040 Chip

Motorola introduces its 68040 microprocessor; the chip, using 1.2 million transistors, quickly becomes the chip-of-choice for 35 computer manufacturers

1990 Transistor

IBM develops a transistor with an operating speed of 75 billion cycles per second

1991 SONET

SONET (Synchronous Optical Network) technology is introduced, creating an international standard for transmission of a wide variety of digital data over fiber optic networks

1991 Multimedia

Multimedia (the combination of audio, motion pictures, illustrations and diagrams, animation, and text) is first introduced to computing; some common elements that help the user enjoy multimedia include CD-ROM disc drives, hard disk drives with ample memory, VGA (video graphics array) monitors with at least 256 colors, software to view moving images, sound cards to replay digitized audio, and microphones for recording; many personal computers are now sold in a multimedia package, featuring some or all of these and other components

1991 Notebook Computers

Most personal computer manufacturers introduce notebook computers; while these machines are convenient for their size (small enough to fit in a briefcase), further development is needed to improve aspects of the monitor, memory capacity, and keyboard functionality

1991 RBOCs

The regional Bell operating companies (RBOCs) receive permission from the U.S. Court of Appeals to produce and deliver online information services

1991 Digital HDTV

The first operational example of digital high definition television (HDTV) is created at General Instrument’s Videocipher development division by Woo Paik and coworkers in San Diego, California

1991 Digital Compact Cassette

Philips demonstrates its digital compact cassette at an electronics fair in Las Vegas, Nevada; the tape is the same size and shape as analog cassettes, and can be used to record audio or other data

1991 Voice-directed Video Recorder

Matsushita develops a voice-directed video recorder; it performs functions such as Stop and Record when instructed to do so by a voice, but it only accepts commands in Japanese

1991 MITI

In Japan, the Ministry of International Trade and Industry (MITI) dedicates $2 billion to a neural network research program with the goal of creating a truly intelligent machine

1991 Skyphone

Skyphone begins installing outgoing-call telephones on airplanes; the telephone signals are relayed around the world by telecommunications satellites, and Skyphone technology gains steadily in popularity

1991 CM-2

Thinking Machines introduces the CM-2 supercomputer with a processing speed of 2 teraflops (two trillion floating point operations per second) and up to 16,000 data processors

1991 PIM

The Japanese Institute for New Generation Computer Technology builds the Parallel Inference Machine (PIM); the PIM uses logical connections between words and images to understand their meanings, rather than using a number-set to process that information

1991 DRAM Chip

Fujitsu, Matsushita, Mitsubishi, and Toshiba announce the result of collaborative work done by the four companies; together, they have developed the prototype of a 64-megabyte dynamic random access memory (D-RAM) chip; IBM and Siemens A. G. of Germany jointly design a similar chip later in the year

1991 Neural Network

Misha Mahowald and Rodney Douglas develop a neural network chip that represents five neurons (the nerve cells in the human brain); it is designed for use in artificial intelligence

1991 Analog Chip

Information Storage Devices produces a chip that can store sound in analog form, eliminating the need to convert audio signals to a digital format; sound is stored in the chip as electrical charges, and the device can store up to 230 of these charges

1991 Pressure Recognition

Marketing begins of computers that use a person's signature as a password; the act of signing one's name for access to computer data is not new, but these computers identify the user by recognizing changes in pressure as the name is signed, rather than relying on the shape of letters alone

1992 RBOCs

The regional Bell operating companies (RBOCs) brace for increased competition in the local telephone service market when an information processing ban on telephone companies is lifted; this paves the way for other telephone companies to begin transmitting signals in markets formerly controlled by RBOCs

1992 AT&T Videophone 2500

AT&T begins selling a videophone for about $1,500; the Videophone 2500 uses a traditional telephone jack to transmit and receive sound and a compressed video picture about 3.3-inches (8.4-centimeters) square; there must be a Videophone 2500 at each end of the phone line, but there is no added expense for making such a call

1992 Cellular Telephones Widespread

U.S. cellular telephone systems begin using digital technology to improve sound quality; the number of cellular telephone users triples

1992 Undersea Laser Illumination

While working for Westinghouse Underwater Laser Systems and Applied Remote Technology, Brian W. Coles designs a camera that uses laser light to illuminate objects for black-and-white undersea photography

1992 IBM SOI

IBM introduces the silicon-on-insulator (SOI) bipolar transistor, a device capable of operating at 20 GHz (the highest bipolar transistor frequency ever attained)

1993 Newton PDA

Apple designs the first personal digital assistant (PDA), the Newton MessagePad; PDAs are criticized at first due to some technical limitations, but it is projected that eventually PDAs (about the size of a small pad of paper) will be capable of transmitting faxes, storing informational databases (such as phone lists, calendars, and business contacts), sending and receiving cellular telephone signals, and letting the user take notes on a dual-purpose display and data-input screen with a digital pen

1993 Subcarrier Signals

FM radio stations in the United States begin using a system already used in Europe to send digital data on the same signal that carries sound waves; among other uses, the radio data system (RDS) replaces many broadcast tests of the Emergency Broadcasting System

1993 Translation

Japanese researcher Toshiyuki Takezawa gives the first demonstration of simultaneous translation over a telephone; first, he speaks the word *moshimoshi* into a computer in Kyoto, which translates the word from audio into Japanese text; the text is sent to a second computer, responsible for translating the word into English; the data is then sent via modem and telephone lines to a computer in Pittsburgh, Pennsylvania that reads the text and pronounces the English word *hello* (the translation of *moshimoshi*) in a synthetic voice; the entire process takes 12 seconds to complete

1993 All-Optical Computer

Harry Jordan and Vincent Heuring lead a team at the University of Colorado that develops the first programmable all-optical computer with the ability to manipulate instructions internally

1993 Intel Pentium Chip

Intel Corporation introduces the Pentium microprocessor chip; it is part of the fifth group of chips in the basic line of Intel microprocessors that power the IBM Personal Computers (PCs) and their clones; the Pentium chip is twice as fast as its best predecessor, Intel's 486DX2

1994 HEXAR

Cray Research introduces HEXAR software to convert data entered as part of computer-aided design (CAD) projects into three-dimensional on-screen computer models; HEXAR reduces the conversion process time of such data from weeks or months to only minutes

1994 Software Agreement

Cray Research leads an industry group in signing an agreement to design software applications for use with massively parallel computers for the U.S. Department of Energy

1994 Macintosh Licensing

Apple Computer announces that it will license Macintosh technology to other computer makers, finally allowing Macintosh clones to be produced for the first time

1994 Intel Pentium Errors

Users discover that Intel Corporation's powerful Pentium microprocessor chip makes errors when performing complex mathematical calculations; in a controversial move, Intel refuses to recall and replace all Pentium chips, instead only replacing chips for individual customers who formally request such a replacement

1995 Cray Computer Corporation

Cray Computer Corporation (CCC) files for bankruptcy protection after sales of supercomputers fall steadily as the machines are replaced by massively parallel processor systems

1995 Telecommunications Act

In the Telecommunications Act of 1995, the U.S. Senate agrees to deregulate much of the cable television and long-distance telephone industries; if implemented, the regional Bell operating companies (RBOCs) will be allowed to offer long-distance telephone services; long-distance telephone service providers (such as MCI, AT&T, and Sprint) will be able to provide local telephone service; cable television operators will be given approval to deliver telephone services over cable network lines; and telephone companies will have the freedom to provide cable television services

1995 Turner and Time Warner Merger Announced

Cable magnate Ted Turner and Time Warner, Inc. announce a planned merger of Turner's broadcasting systems into the Time Warner family. The deal, worth $7.5 billion, will give Turner a 10% ownership in Time Warner and he will become Vice Chairman of Time Warner, Inc.

1995 AT&T Splits

AT&T announces plans to divide into three independent, publicly owned, global companies. The new entities will focus on 1) communication services (this company will retain the AT&T name); 2) systems and technology, including all of AT&T's non-computer products and equipment; and 3) AT&T's existant computer business, AT&T Global Information Solutions.