David vs Goliath or Mice vs Men?
Production Studio Size in the Entertainment Industry

Chair
Pauline Ts'o, Rhythm & Hues

Panelists
Theresa Ellis, In-Sight Pix
Ralph Guggenheim, Pixar
Brad Lewis, Pacific Data Images
Ron Thornton, Foundation Imaging

The panelists come from a variety of backgrounds - some have helped small companies grow large, others have left large studios to form small ones. They all have senior management experience in markets that span the entire spectrum - feature films effects, television commercials, motion-based simulator rides, animated features, television series, animated shorts, broadcast graphics, special venue films, and interactive multi-media. The panel will draw upon this diverse history to discuss one strategic aspect of surviving in the entertainment industry.

Introduction

The appetite for digital content has grown enormously over the past eight years. The entertainment industry seems finally convinced that computer animation and digital effects are viable tools for many of its markets including feature films, television, theme parks and interactive multi-media. As with any increase in demand, there has been a corresponding increase in supply and, of course, a proliferation of approaches to cornering market share.

The size of a production studio affects every aspect of its competitive edge including hardware capacity, software capability, the depth of its creative environment, the types of services it can provide its clients, and which clients it can reach. Does a studio choose its size or is it chosen by the marketplace? And are the stereotypes associated with company size valid?

For example, one of the biggest problems facing studios today is finding qualified 3D computer animators. There are typically three major points that become the crux of an applicant's decision - career opportunity, standard of living, and salary. Studio size can have a drastic effect on each of these factors - for instance, a small studio typically asks an individual to perform in many different areas while a large one often allows an individual to perfect a particular skill. Which set of advantages and disadvantages is more appealing to more animators is becoming increasingly crucial. A studio that has work, but not enough animators, is in as much trouble as a studio in the opposite situation.

Financial stability may also depend on strategic diversification. Each market has its own particular financial cycles, such as television's fall premiere of new shows or the Thanksgiving release of major feature films. To smooth the rigors of boom-or-bust cash flow, most studios look for a balance between several markets. Large studios tend to pursue projects that take advantage of, and therefore justify, their inherently larger capacity. This has historically meant that certain markets are dominated by larger studios and other markets, by smaller studios. But technology for entertainment is extremely fluid. Will the small studios be the small, adaptive mammals of the future or will the large studios be the 800-lb gorillas?

Some believe that the technology is beside the point and what will really determine the long-term success or failure of individual computer animation studios is their ability to own creative content. But this development of creative property can be an expensive and risky endeavor, dependent upon just the right combination of talent, resources, and timing. Again, size can play a crucial role in the ability of studio to seize opportunities today for the future.

It will certainly be interesting to look at this issue again in another eight years. Given changes in commercial software, the rapid decline in hardware costs and the even faster expansion of communication and information flow, it may be that size won't matter at all.

Theresa Ellis

In comparing large CGI production companies with the smaller "boutique" streamlined companies such as In-Sight Pix, one may find that while the overall approach is very different, basically, they are much the same. We use the same high-end equipment and software as the larger companies. We work on effects and CGI elements with live action for commercial and film projects, with quality and creativity being the ultimate goal. Our client base and reputation is also world wide. On the other hand, having worked for several large and small companies, I would say the big difference between them is the company philosophy. In-Sight Pix is a small studio that, well, thinks globally and acts locally.

What makes us unique from the larger companies is that we have more control over the creative process of realizing the director's vision. All people involved are key. We provide and work with people who are very excited about what they do and are knowledgeable about every aspect of how to best see the project through. These qualities are evident in our work. As a whole, the ability and necessity to continually learn the latest is encouraged. Our work is respected by many repeat clients who constantly challenge our abilities with new ideas, as well as with young software companies who want to hear our new ideas to incorporate into their software.

Naturally, there is always the option of growing into a larger company or allowing one large project to take over the company. However, to do either of these would give up the control and personal relationships we have developed with our clients. For now, as a small company, being small is what keeps us strong and our work innovative.

Ralph Guggenheim

Pixar's unique environment houses a feature film animation studio side-by-side with a small TV commercial production unit. Toy Story, the first ever full-length computer animated feature film employs the talents of 100+ animators, technical directors, editors, artists, illustrators and production management staff.

Simultaneously, Pixar Shorts, our short-form animation group, has won two Clios in as many years for its TV commercial work with a small team of 15. These two groups produce highly creative work, though with very different markets and working styles. Is Pixar a large studio or a small boutique? How can these two diverse groups foster creativity and produce high-quality work with such different agendas?

Brad Lewis

Digital effects and computer animation production companies large or small are faced with similar challenges. We have to create and produce compelling and challenging visuals. We need to recruit and attract talented computer artists and animators, while maintaining a creative and challenging environment. We must also possess strong management skills and run viable businesses.

The entertainment industry is largely a traditional field that has existing production models that don't work for our industry. We are a different breed that combines a variety of disciplines that mesh into a new configuration: art, animation, computer science, software development, r&d, film and video, business and management. Many companies are pursuing these issues along very different paths that are based upon individual experience, strength, opportunity and various degrees of planning.

There are no exact answers, but there are practical examples of how our industry is currently approaching the challenges. There has been explosive growth over the past two years in which many companies have desperately responded in ways that are not sustainable. There is the major challenge of determining what our industry will be, what it could be, and ultimately, what should we be?

Ron Thornton

By using digital technology to create visual effects, we are continually faced with a constantly changing technology base and are forced to make decisions now which will effect our capabilities in the near future. Given this climate, we feel a smaller company is better able to adapt to quickly changing technologies than a larger company, because a smaller company doesn't have to invest in the volume of technology that a larger studio requires. Therefore, we can make both major and minor changes in the technology we use, with very little loss of time or revenue.

However, regardless of the size of the company and the equipment its artists use, the real focus is on the artist, not the technology. A computer, by itself, is not creative - it is the artist who creates the visual effect. The technology gives us more creative choices and increases our output, but it is important to remember to utilize the proper tool for the job. As our company tends to work mainly in the television arena, we can tailor our investment in digital equipment to suit our output. This doesn't have any effect on the quality of the visual - it would still be as spectacular on the big screen - but it does allow us to maintain great quality and meet a deadline.

In addition, because we don't have a huge overhead to support (in terms of equipment and software), we can take on work that large companies cannot afford to, or, conversely, decline to participate in projects which we feel are ill-conceived, regardless of the amount of money involved, which is something a big studio may not be able to afford to do. We feel it is important to promote our company's strengths and not attempt to service all areas of the marketplace.

Regardless of the size of the visual effects company, we are still governed by 3 variables: schedule, economy, quality - pick two.

A National Research Agenda for Virtual Reality: Report by the National Research Council Committee on VR R&D

Chair
Randy Pausch, University of Virginia

Panelists
Walter Aviles, Massachusetts Institute of Technology
Nathaniel Durlach, Massachusetts Institute of Technology
Warren Robinett, Virtual Reality Games, Inc
Michael Zyda, Naval Postgraduate School

In 1992, at the request of a consortium of federal agencies, the National Research Council established a committee to "recommend a national research and development agenda in the area of virtual reality" to set U.S. government R&D funding priorities for virtual reality (VR) for the next decade. The committee spent two years studying the current state of VR, speculating on where likely breakthroughs might happen, and deciding where funding could have the greatest impact. The result is a 500-page report that will have tremendous effect on what does and does not get funded in Virtual Reality research by agencies such as ARPA, the Air Force Office of Scientific Research, the Army Research Laboratory, Armstrong Laboratory, the Army Natrick RD&E Center, NASA, NSF, NSA, and Sandia National Lab.

The committee's report tries to "describe the current state of research and technology that is relevant to the development of synthetic environment systems, provide a summary of the application domains in which such systems are likely to make major contributions, and outline a series of recommendations that we believe are crucial to rational and systematic development of the synthetic environment field."

The purpose of this panel is to report the (often surprising) recommendations in the committee's report. Few researchers will have time to read this very influential document, but this forum will disseminate the basic highlights, and attempt to explain some of the more fractious points that the committee dealt with. For example, the report recommends "no aggressive federal involvement in computer hardware development in the [virtual reality] area at this time."

Based on last year's SIGGRAPH, Virtual Reality is one of the hottest areas for the computer graphics community, and funding is clearly needed from the federal government. Industrial sources are not viewed as having sufficiently long-term strategies to advance the field in many necessary areas. Therefore, the funding priorities and strategies discussed in this report may have a direct impact on the future directions of the SIGGRAPH community.

The report itself is Virtual Reality, Scientific and Technological Challenges, copyright 1995 National Academy of Sciences; ISBN 0-309-05135-5, Nathaniel I. Durlach and Anne S. Mavor, editors.

The purpose of the panel is to disseminate the report, the various panelists will be covering the following areas of the report and its recommendations:

Durlach: explanation of the committee's charge, government policy implications, and a high-level overview of the anticipated impact.

Pausch: description of the recommendations regarding the need for psychologists and evaluation criteria, and the recommendations in the area of education.

Aviles: discussion of recommendations regarding teleoperation and haptic/force feedback.

Robinett: discussion of human-machine interface recommendations, augmented reality, and sensory extension via VR.

Zyda: discussion of networking and hardware recommendations.

PANELISTS

Randy Pausch, University of Virginia (panel organizer) is an Associate Professor of Computer Science at the University of Virginia. He received a B.S. in Computer Science from Brown University in 1982 and a Ph.D. in Computer Science from Carnegie Mellon in 1988. He is a National Science Foundation Presidential Young Investigator and a Lilly Foundation Teaching Fellow. He currently leads the University of Virginia User Interface Group, which is developing the Alice VR system. His primary interests are human-computer interaction and undergraduate education.

Nathaniel Durlach, MIT, (chair of the NRC committee) is a senior scientist in the Department of Electrical Engineering and Computer Science at the Massachusetts Institute of Technology and has been co-director of the Sensory Communication Group in the Research Laboratory of Electronics there for over 20 years. He has also been a visiting scientist in the Biomedical Engineering Department of Boston University for five years. He received an M.A. degree from Columbia University in mathematics and an M.A. degree from Harvard University in psychology and biology. He is the author (or coauthor) of numerous book chapters and refereed articles in such journals as Perception and Psychophysics and the Journal of the Acoustical Society of America; he continues to review articles, proposals, and research programs in the field of pschophysics; and he has recently been selected to receive the silver medal award for outstanding work in psychoacoustics by the Acoustical Society of America. Recently, his research interests have focused on teleoperator and virtual environment systems, with special emphasis on the human-machine interfaces used in such systems. He is cofounder and director of the MIT Virtual Environment and Teleoperator Research Consortium, as well as cofounder and managing editor of the new MIT Press journal Presence: Teleoperators and Virtual Environments.

Walter Aviles, MIT, has over a decade of experience in the design and development of advanced human/machine interfaces and robotic systems. His technical-emphasis areas include real-time control and integration architectures for distributed robotic

and sensor systems and multi-modal, spatially-oriented, interactive human /machine interfaces. He is one of the founding members of the Virtual Environment and Teleoperator Research Consortium (VETREC) and is an Associate Editor of the MIT Press journal Presence. Currently a Ph.D. candidate at MIT, Walter is responsible for the day to day management of the Virtual Environment Technology for Training Research Testbed. His current research involves exploring the efficacy of multi-modal user interfaces (MMUIs) in training applications After graduating from Stanford University in 1982, Walter spent the next 11 years at the Naval Ocean Systems Center (NOSC), a US Navy research and development laboratory.

Warren Robinett, Virtual Reality Games, Inc., is a designer of interactive computer graphics software and hardware and president and founder of Virtual Reality Games, Inc., a developer of virtual reality video games for the home market. In 1978, he designed the Atari video game Adventure, the first graphical adventure game. In 1980, he was cofounder and chief software engineer at The Learning Company, a publisher of educational software. There he designed Rocky's Boots, a computer game that teaches digital logic design to 11-year-old children. Rocky's Boots won software of the year awards from three magazines in 1983. In 1986 Robinett worked as a research scientist at the NASA-Ames Research Center, where he designed the software for the Virtual Environment Workstation, NASA's pioneering virtual reality project. From 1989 to 1992 at the University of North Carolina, he directed the virtual reality and nanomanipulator projects. He is an associate editor for the journal Presence.

Michael Zyda, Naval Postgraduate School, is a professor in the Department of Computer Science at the Naval Postgraduate School. He is also the academic associate and associate chair for academic affairs in that department. His main focus in research is in the area of computer graphics, specifically the development of large-scale, networked, three-dimensional virtual environments and visual simulation systems. He is the senior editor for virtual environments for the quarterly Presence; for that journal, he has coedited special issues on Pacific Rim virtual reality and telepresence.

Set-Top Boxes - The Next Platform

Chair
Jonathan Steinhart, Jonathan Steinhart Consulting, Incorporated

Panelists
Derrick Burns, Silicon Graphics, Inc.
James Gosling, Sun Microsystems, Inc.
Steve McGeady, Intel, Inc.
Rob Short, Microsoft, Inc.

Successive price/performance iterations in computer and computer graphics technology have increased the penetration of this technology into everyday life. Access to early computer graphics technology, based on large computers and specialized displays, was limited to computer professionals. A larger portion of the population had access to high performance computer graphics technology as prices dropped and performance increased through successive generations of mini-supercomputers, workstations, and personal computers. However, this population is still primarily limited to the workplace. Set-top boxes are poised as the next big price/performance step. With this step, computer graphics and high performance computing technology are expected to achieve significant penetration into the home market.

How's all this going to happen? What hardware is being built for set-top boxes? What software is going to run on them, both at the systems level and the application level? What communications technologies are going to support all this? What's the market?

Who is going to use services provided via set-top boxes? We're already running out of hours in the day to watch television. Are set-top boxes just for entertainment or are they going to facilitate telecommuting, shopping, school homework, etc? Will the television become a household bottleneck?

Will set-top boxes succeed in the home market or will elements of the technology be absorbed into the business environment?

There is considerable disagreement as to the answers to these questions. Many companies have joined into partnerships to try to grab a portion of the projected market. There's a lot of hype, as there are no real product offerings today.

Derrick Burns
Interactive television is much more than video on demand. It is a new medium by which the consumer is both educated and entertained. The settop box provides access to this medium. It serves both as a gateway to a vast repository of stored multimedia information and as a tool that can navigate through this store, creating for the each individual viewer a presentation tailored to his/her desires. Personalization demands substantial processing power. To meet my vision of interactive television, the settop must offer not just playback of audio and video, but it must synthesize sound and imagery as well. The settop box will provide synthetic spatial (3D) audio and texture-mapped 3D graphics, and it will provide these features at very low cost. This settop box is a true SYNTHESIS ENGINE. The synergy of synthesis and access to a broadband network will enable new services whose markets will eventually dwarf that of simple video-on-demand.

James Gosling
It's madness out there. Every vendor is doing something different, usually proprietary. They all dream of controlling the universe and being the next MicroSoft. But even MicroSoft is having problems because few want to be dominated by the current Master Of The Universe. (The other Master Of The Universe, Nintendo, is similarly hemmed in by its success) Settop boxes are caught in the usual cost trap: features that lead to Nirvana are promised, but when the cost is examined, enthusiasm drops. Some try to get around this by making the settops very cheap, and putting the intelligence in downstream servers, but all they succeed in doing is shifting the cost.

My personal guess is that there never will be "intelligent set top boxes": intelligence will continue to be in personal computers, whose multimedia capabilities will continue to grow. People are used to spending a few thousand dollars for them, while they expect set tops to be free. I don't think any of the high-function set top experiments will achieve the volume necessary to attract a significant developer community. The actual features available on the box are almost inconsequential to a developer relative to the market size.

Steve McGeady
We have been bombarded lately with breathless reports about an 'Information Superhighway,' coming soon to your home. But experts can't seem to agree on what devices will connect your home or office to the Infobahn, what services will be offered on it, or what business and technical form this information revolution will take. Intel is at the heart of an industry that has delivered a 1000-fold increase in computing power over the last 15 years. Intel's Communications Technology Lab is now charting a course to integrate the personal computer with the rapidly-increasing communication bandwidth that is being made available to enable new applications in the office and home. In order to deliver a rich and truly interactive experience, the device in your home needs computing power and memory, high-resolution display, mass storage, and multiple high-bandwidth two-way communication channels. It needs to be programmable by others than the broadcast industry, and it needs to offer the user interactivity beyond simple yes/no answers and selections. Over 30 Million homes already have a device that begins to meet these criteria - the personal computer.

Rob Short
The key to gaining consumer acceptance of interactive TV is ease of use. If the average consumer can't find their way through the tens of thousands of services offered to them interactive TV will flop. Microsoft is concentrating on developing intuitive and fun interfaces for TV users. The challenge is that these interfaces must be much more powerful than those on todays PC's while at the same time being much easier to learn and use. High quality computer graphics are the enabling technology for these new user interface paradigms. How will these systems evolve?, we don't know. We do know that there are 20 million PC's in U.S. homes today, and that these PC's have capabilities that will not appear in set-tops for several years. Many of the concepts and services will appear on the PC earlier than on the set-top, perhaps in a different form. As technology advances we expect to see a convergence of the services provided through PC's and set-tops although the user interface paradigm may need to be totally different.

Museums Without Walls: New Media for New Museums

Chair
Alonzo C. Addison, University of California at Berkeley

Panelists
Douglas MacLeod, The Banff Centre for the Arts
Gerald Margolis, Simon Wiesenthal Center
Beit Hashoah Museum of Tolerance
Michael Naimark, Interval Research Corporation
Hans-Peter Schwarz, MediaMuseum, ZKM (Center for Arts and Media Technology)

What role should computer graphics, multimedia, virtual reality, and networks play in the 'Museum of the Future' and what effect will these technologies have upon it?

This panel is focused on the evolving nature of the museum in the information age. Society's traditional methods of presenting and exhibiting cultural, social, and historic artifacts and information are being profoundly affected by the proliferation of computers, multimedia, and networks. Museum directors and designers around the world are rapidly discovering that older passive and static presentation models are increasingly inappropriate in an 'instant gratification' society raised on television and accustomed to computers and other new media. Can and should museums attempt to keep pace with the media of the 'Nintendo' generation? A proliferation of World Wide Web "museum" sites on the Internet begs the question of what makes a museum today-is physical presence still a defining criteria? Is an interactive, networked 'virtual museum' a viable substitute for a physical place, or do we need both? How can and should traditional museum facilities work with and link to virtual ones? Just as a good novel can be more powerful than an interactive, multimedia CD-ROM story, technology alone does not necessarily make a better museum. How much media is appropriate? How interactive should it and does it need to be? When does media begin to overpower the message of the museum itself? How do we overcome (or should we even care about) problems of graphic realism 'brainwashing' visitors who may come to museums to see 'truths' about their society and history? With technology providing the potential to customize the museum to the visitor's interests, new dilemmas arise, and old debates resurface. Do the curatorial advantages of being able to present multiple 'tours' through a virtual site outweigh the losses of not being able to physically see an artifact itself? And how does a museum fund high technology with computer power and features advancing at a dizzying pace? These and similar questions are among those the panelists are grappling with in their own work, have previously discussed, and are looking forward to debating with each other and the SIGGRAPH audience. The panelists bring a multitude of perspectives to the discussion. From roles as museum directors and designers, to educators and artists, they have all dealt with the issues surrounding the museum of the future. They have similarly faced the challenges of being at the technologic forefront-from the difficulties of synchronizing and ensuring nonstop operation of a multitude of electronics for days on end, to the problems of creating and maintaining a state-of-the-art showplace in the era of rapid media obsolescence. Although many of the experiences of the panelists are in many respects similar, different museums, artifacts, and ideas require different types and levels of technology-what works at the Museum of Tolerance may not be appropriate at the Getty or the Exploratorium.

Douglas MacLeod
New media that simply mimics a walkthrough of the paintings and sculptures of a museum is a waste of time and effort. The possibilities of real-time, interactive graphics and sound demand much more. Coupled with emerging high-speed, high bandwidth networks, engaging and evocative exhibits are possible that question the idea of a static collection inhabiting a single space. Converging new media are already undermining the traditional idea of a museum. Art pieces produced at the Banff Centre through its Art and Virtual Environments Project demonstrate the potential of new cultural experiences; and testbed networks such as WURCNet (Western Universities Research Consortium) in Western Canada demonstrate new delivery systems and content. Together the two trends of real-time interactions and high-speed networks will revolutionize our experience of culture and radically transform the institution of the museum.

Gerald Margolis
The Museum of Tolerance is a media-rich facility that reflects and comments on social problems in the United States and reprises the watershed event of the 20th century, the Holocaust. Since its opening in February 1993, the Museum has garnered significant attention and become a regular stop for adults, school groups, and professional organizations interested in diversity-training. As the first Museum to discuss the Holocaust within the context of prejudice and aggression in our society, it employs diverse multimedia, from low tech physical props and sets to state-of-the-art interactive computer displays, to help visitors confront personal feelings and beliefs and thus convey a powerful, if sometimes unpleasant, message. Ultimately, the Museum is interested in communicating values and ideas which are of greater importance than the vehicle-multimedia-of delivery. The Museum is interested in presentation and interpretation as these strategies surround and reflect issues of social justice and inter-ethnic relations.

Michael Naimark
Museums WITH walls will offer experiences very different from-but symbiotic with-museums without walls. As public spaces, new media can be used for unique immersive environments on a scale much larger than for homes, with high resolution, panoramic, stereoscopic visuals, and high quality multi-channel audio, haptic feedback, and novel input. Museums with walls will always collect and display original art and artifacts. Representations of such work, while convenient and economical, will never completely replace the originals. Museums of the future can take advantage of a powerful symbiosis by planning to be both a node on the global network and a place for unique sensory rich experiences.

Hans-Peter Schwarz
The Museum of the Future will be an interactive art gallery on the data highway. However, we still need physical museums as bases, or buildings, to link individual places across the world together. Because the museum is more than a storage room or repository for artwork, it has to be a meeting place as well as a forum for discussions, experimentations, and education. The main outlet for this ongoing dialogue will be “Salon Digital”-an interactive electronic Cafe which encourages social and theoretical discourse. The MediaMuseum, planned in the Center for Art and Media Technology in Karlsruhe, will be such a forum. A combination of the virtual museum and the real sensual museum, it will be a place to confront the visitor with a new view of history as well as to talk about the presence and the future of media art and media technology. Its primary focus is to make a critical use of the unbelievable possibilities of new media technology.

Afterword
This panel is an outgrowth of the discussions of an interdisciplinary group of computer graphic and multimedia specialists, museum directors, designers, artists, and educators with a common interest in ‘The Museum of the Future’. This international museum group was first brought together by the University of California at Berkeley and the University of Ferrara, Italy for several days of meetings during 1994 to think about and debate issues of museums with and without walls. It is our hope that through this panel some of what has been learned by our group can be shared with the greater SIGGRAPH community.

Interactive MultiMedia: A New Creative Frontier or Just a New Commodity?

Chair
Ruth E. Iskin, Head, Visual Arts & New Media, UCLA Extension

Panelists
Mikki Halpin
Michael Nash
George Legrady
Rodney Alan Greenblat

The last one hundred and fifty years have generated an avalanche of visual technologies through which an ever expanding visual culture has been marketed to mass audiences. From the invention of photography in 1839 to film in the 1890's and the marketing of television in the 1940's-50's, our steady diet of images has increased our voracious appetite by quantum leaps. In the 1990's we are faced with another invention of great potential, much hype and as yet unforseen repercussions—interactive multimedia. "Employing these new media requires inventiveness as well as overcoming the double jeopardy of techno-phobias and the strictures of a paper/print design mentality; it calls upon practitioners operating in a new electronic paradigm whose parameters are still forming to recreate the roles of designer, artist and entertainer.." It remains to be seen to what extent this new communication commodity truly represents a new artistic frontier. A multi-sensory dynamic form of communication, multimedia enables a new unprecedented level of intermediality between the previously relatively separate forms of writing, voice, music, still images, motion pictures and video. It promises innovative intermedia relationships between these in non-linear, user-driven options incorporating the interactive game format along with more passive reception and unlimited playback options. To be sure, it recycles older communication products from photography, film and books to museum art collections.

Is multimedia as yet more than the sum of its recycled parts? Michael Nash states that "The promise of the new media lies in its ability to intertextualize the elements that constitute our tele-visual systems of meaning with a depth and richness that will enable artists to more fully mirror the activities of consciousness, and to engineer new dialogues between its reflection and articulation, between reading and writing."

Interactive multimedia are a genre of culture commodities that stimulate consumer interest with the promise of repeated and engaged usage. Yet "the significance of interactivity extends far beyond an emergence of a more enticing set of commodities, though that they certainly are. Interactivity is also not reducible to a new art genre, though that too, it certainly is becoming. Rather, we intuit interactivity as a fundamental change in socialized patterns of intersubjectivity, forms of knowledge and communication and relationship to objects. In the process, notions of self, agency, art and commodity are reconfigured...It should come as no surprise then that art... is claiming interactivity as its arena along-side with inert objecthood." Artists and users/consumers alike have a heightened sense that multimedia plays a crucial role in the tidal wave of changes sweeping the late twentieth century world of communications. The questions that arise are vast. This panel will begin to tackle some of them.

Panel Goals and Issues
This roundtable of artists and producers share brief segments from their most recent work and address a range of questions: What makes for successful interactivity and multi-sensory communication? The highs and lows of making multimedia for the mass market: Can artistic innovation flourish in a fiercely competitive market, corporate climate and bottom-line driven business plans? Are we entering a Renaissance or an electronic sweatshop? What is the potential of digital cash for Internet distribution by artists? And what are the realities of selling creative work to multimedia companies: How are artists' rights and copyrights effected?

Panel participants' Statements

Mikki Halpin: Independent Multimedia Producer, columnist on new technologies for Filmmaker, Computer Player, CD-ROM Player, Hun, and an instructor of "The Culture of Multimedia," at UCLA Extension brings a rich perspective as a writer and multimedia producer. Her past encompasses both Hollywood development and Ivy League theory; her roots and connections span the fringes of the art world and the mainstream multimedia publishing world.

Statement
A friend of mine who runs a media art program recently confided in me a fear she has about the future, a future in which, she said, all the artists she knows and respects end up working for CD-ROM companies. She envisioned the artists as virtual slaves to their given employer, a commodity to be traded or secreted away, like Hollywood stars of old. She may not be far off.

Faced with dwindling government and community resources, and excited by the possibilities of interactive media, many artist are forming new alliances with industry. But, unlike corporate patronage of the arts evidenced in corporate art collections and sponsorship of exhibitions, multimedia companies tend to expect more from an artist than just their work. It is not unusual for a company to demand ownership of such things as character rights, amusement or even theme park rights in perpetuity from an artist before agreeing to produce or distribute the artist's work. In return for this complete abandonment of his or her rights, the artist receives a small advance against the royalties. Demands which would be scoffed at in negotiations for literary or theatrical rights are de rigueur in multimedia. The internet, with its growing consumer base and increasing multimedia capabilities, offers many possibilities to artists. As remuneration engines such as "digital cash" and other protocols emerge, perhaps artists will be able to take hold of their own destiny without selling their souls."

Michael Nash: President and Creative Director of Inscape, a multimedia company he formed in partnership with Home Box Office and the Warner Music Group brings both art world expertise as a former museum curator of video art and as producer of CD-Rom titles at The Voyager.

Statement
Cultural coups like the emergence of San Francisco cult bands The Residents as CD-ROM stars demonstrate opportunities presented by the new media to establish new relationships between artists and their constituencies. As business-plan driven multimedia product developments efforts fall embarrassingly short of not just artist expectations but also economic projections, successes like Myst make it increasingly clear that the inception of new artistic forms is a visionary enterprise driven by the exigencies of personal creative expression.

The articulation of transformative new versions changes what we expect of new technology or any property of new technology. But in order for artists to extend their impact beyond formal innovations and truly change cultural dialogue, it is necessary to engage in marketing. Marketplace dynamics and creative strategies offer opportunities to develop a new audience for art in the digital culture of the future.

George Legrady: Associate Professor, Information Arts in the Art Department at San Francisco State University and Winner of the 1994 "New Voices, New Visions," competition by the Voyager, Wired, and Interval Research, brings the perspective of a fine artist. His two decades of producing work in photography and conceptual art have recently culminated in a new synthesis by pioneering fine art interactive multimedia work. Paying close attention to aesthetic issues, the construction of meaning, ideology and the interweaving of personal and historical circumstances, his work constitutes a true breakthrough in the fine art of interactive multimedia.

Statement
Metaphor-based interfaces form organizational models that situate the viewer of multimedia works and provide a way of accessing and understanding data. By knowing "the story" or metaphor, the viewer can successfully navigate inside the interactive program. These environments promise to be the key site for innovative developments of linguistic, symbolic, aesthetic, sensory and conceptual nature.

Rodney Alan Greenblat: Artist, The Center for Advanced Whimsy, brings extensive dual experience in the New York art world (from the 1980s off-beat Village scene to the prestigious Whitney Biennial) coupled with popular success as a multimedia artist who has broken through to the mass market.

Statement
It is ridiculous to talk about "multimedia" being new. Artists have been creating multimedia since cromagnon man first scratched an image of his grandmother being trampled by a mammoth and then sang a song about it. The hype really seems to be about some kind of viewer-controlled experience, or possibly it is just peoples preoccupation with technology. Whatever it is, the digital medium seems to be a great way to make money in the late 20th century. Unfortunately, few have really profited from this fad.

Making computer art is a high challenge that calls for multiple talents, extreme patience and total devotion. A degree in law or an MBA is an advantage if you wish to actually publish what you make. Nevertheless, I really love my computers. They are like brilliant little parrots waiting for idea crackers to digitize and spit out as a colorful animated show. They regularly fuss and refuse, and constantly ask "OK?" When one of them is sick I am filled with frustration and concern. When everything finally works, and the creation is finished, I have an art work that is part magical part math. It glows at night, fits on a small disk, and can travel around the world in a few minutes. It is part audio recording, part movie, part novel, and part painting. It is a medium for building worlds, and the kids really like it.

Integrating Interactive Graphics Techniques with Future Technologies

Chair
Theresa Marie Rhyne, Lockheed Martin / U.S. EPA Scientific Visualization Center

Panelists
Eric Gidney, College of Fine Arts/University of New South Wales, Australia
Tomasz Imielinski, Rutgers University
Pattie Maes, MIT Media Laboratory
Ronald Vetter, North Dakota State University

This panel examines the need to integrate computer graphics techniques with other methodologies and technologies such as mobile and wireless personal assistants, intelligent agents, cartography, human perception, voice recognition, interactive television, cooperative computing, and high speed networking. The need to develop new interfaces and displays which reflect the social changes associated with the way people will interact with integrated computer systems and the information highway is addressed.

Theresa Marie Rhyne: Cartography, Visualization, & Decision Support

Interactive computer graphics techniques are just one component of integrated decision support systems. For comprehensive interpretation of geographically referenced data, visualization environments need to be merged with large remotely distributed and networked spatial data bases. Three dimensional isosurface and volume rendered images must be referenced against cartographic, statistical and plotting displays for effective interpretation of scientific results. The requirements of research, policy analysis, and science education are not necessarily the same. Therefore, user interfaces need to be flexible in their design to support these different viewpoints and interpretations of data. Decision making is rarely done in a vacuum but rather is a collaborative process. To support these collaborative efforts, interactive computer graphics techniques will need to merge with multi-media tools for desktop and wireless videoconferencing, cooperative computing technologies, mobile ways for collecting and accessing data, and high speed networking.

A geographic decision support system which is comprehensively integrated will alter the perceptual thinking of individuals and communities. This will result in differing interpretations of information and the need to build computing tools which visually display these discerning viewpoints and the paths taken for arriving at the results.

Tomasz Imielinski: The Challenge — User Interfaces for Mobile Users

Palmtops such as the Newton or HP 100LX are equipped with very small screens. Keyboards with these machines will likely be of little use. This requires a new approach to user interface design. There will be a growing role for pens and speech recognition. Additionally a few companies are exploring "magnifying technology." This allows the user to magnify the size of the screen with little effect on resolution through some form of headmounted display. Voice activated input will be very useful in the car, while less likely in public places where visual interfaces will still remain dominant.

What is the nature of applications which will be run on palmtop computers? Many such applications will be location dependent and deal with the area immediately surrounding the user such as a local supermarket (shopping), restaurant and movie theater (entertainment), and local yellow pages (business). Thus, we define the metaphor of a map centric interface. At any location, the user sees a local map, as a background on his mobile computer screen. This display plays the role of a "magnified eye" which sees further than the real eye and provides labels and interpretations of "whats around." Additionally, the interface will allow rotation and repositioning of images on the screen to reflect the current location of the user. A user standing in front of a building will readjust the mobile computer image to his own unique position, This feature will use information positioning devices such as global positioning systems (GPS).

Summarizing: new hardware restrictions and developments as well as new applications call for revolutionary approaches to user interfaces on small battery powered terminals. Due to battery power limitations and bandwidth restrictions, especially outdoors, CPU intensive visual interfaces will have to be ruled out. There is a need for new solutions, which are attractive to the naive users, while not overly resource consuming.

Ronald Vetter: High Speed Networking

Recent advances in communication networks, computer hardware, software, and visualization are generating interest in the cross- fertilization of application areas . Interaction with massive amounts of three dimensional images, generated in real-time, requires communication networks with high data rates and low latency. The sheer volume of data that must be transmitted in these short periods of time requires networks running at multimegabit speeds. The deployment of high speed networks will allow the integration of computer-generated and real-world imagery to finally reach the desktop.

An example of this kind of interaction is exemplified by an application called TerraVision. In TerraVision, the integration of remote databases, including massive amounts of heterogeneous data (e.g., aerial photography, satellite imagery, digital elevation models) on mass-storage systems, and temporal data from a real-time global positioning satellite system were transmitted over a high speed network. This enabled a U.S. Army commander to "drive through" and "see the battlefield" from a remote workstation. Global positioning sensors were used to track vehicles which were then integrated as 3-D objects in real-time into the terrain image display. TerraVision was developed over a wide-area, switched asynchronous transfer mode (ATM) network of supercomputer systems, gigabit LANs, graphics workstations, mass storage systems, and multimedia facilities.

The impact of network and display technology is also seen by the rapid growth of graphical-based browsing tools on the Internet. NCSA Mosaic type browsers allow wide-area distrib-

uted asynchronous collaboration and hypermedia-based information discovery and retrieval. One concern users have with existing Internet browser tools involves the overwhelming number of possible links (choices) to select from. It is also difficult to recall where a particular piece of information is located. In the future, intelligent interface agents will be able to learn particular interests, habits, and preferences of individual users and help them obtain information when they need it. This will add much more flexibility to many of today's closed hypermedia- based systems.

Eric Gidney - Collaboration in Media & Design Pre-Production

Real-time communications presents a different, more urgent and more sociable paradigm then the human-computer interaction we normally associate with computing. Asynchronous collaboration does not provide the benefits of rapid contextualisation and decision- making that are achievable in real time.

Distributed work environments are now common, but the technology of sharing favourite applications in real time is not readily accessible. Companies need to be able to integrate application sharing into their current work and social contexts. This includes requirements for mobile computing, which may impose constraints on what can be shared.

Media and design companies that work visually need to share images over distance in real time. However, they will have to rationalise bandwidth utilisation versus cost. It may be better, for example, to provide good, fast shared graphics rather than poor videoconferencing.

Pattie Maes: Intelligent Agents & Personal Assistants

Computers are becoming the vehicle for an increasing range of everyday activities. Acquisition of news, information, and mail, as well as social interactions and entertainment, are becoming more computer-based. Simultaneously, more untrained users are interacting with computers. This number will rise as technologies like hand-held computers and interactive TV increase in popularity. Unfortunately, these technological developments are not going hand in hand with changes in the way people interact with computers. The currently dominant interaction metaphor of direct manipulation requires the user to initiate all tasks explicitly and to monitor all events. This metaphor will need to change if untrained users are to make effective use of the computers and networks of tomorrow.

Techniques from the field of Artificial Intelligence, in particular "autonomous agents," can be used to implement a complementary style of interaction. Instead of user-initiated interaction via commands and/or direct manipulation, the user is engaged in a cooperative process in which human and computer agents both initiate communication, monitor events and perform tasks. The metaphor used is that of a "personal assistant" who is collaborating with the user in the same work environment. The assistant becomes gradually more effective as it learns the user's interests, habits and preferences (as well as those of his or her community). Notice that the agent is not necessarily an interface between the computer and the user. In fact, the most successful software agents are those that do not prohibit the user from taking actions and fulfilling tasks personally.

The premise of the talk is that the ideal interface for agent-human collaboration consists of a virtual graphical world in which the agents are depicted as life-like computer characters. I will demonstrate such a system, called ALIVE, which allows a user and an agent (or agents) to co-inhabit a semi-real, semi-virtual 3D environment. In contrast with traditional virtual reality systems (goggles and gloves systems), the ALIVE system allows wireless, full-body interaction. We use a single CCD camera to obtain a color image of a person, which we composite into a 3D graphical world. The resulting image is projected onto a large screen which faces the user and acts as a type of "magic mirror": the user sees herself surrounded by objects and agents (real as well as virtual ones). Computer vision techniques are used to extract information about the person, such as her 3D location, the position of various body parts as well as simple gestures performed. In addition, simple audio and speech processing allows the user to complement the communication with verbal and sound- based cues. Because of the presence of agents, the system does more than the obvious direct-manipulation style of interaction. It provides for a powerful, indirect style of interaction in which gestures can have more complex meanings, which may vary according to the situation the agents and user find themselves in.

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Videogame Industry Overview: Technology, Markets, Content, Future

Chair
Jane Veeder, Time Warner Interactive

Panelists
Mark Stephen Pierce, Time Warner Interactive
Eugene Jarvis, Williams/Bally/Midway
John N. Latta, 4th Wave, Inc.
Heidi Therese Dangelmaier, Hi*D
Jez San, Argonaut Software, Ltd.

Description

While innovative (but secretive) early on, the videogame industry is now rejoining the computer graphics mainstream. In production, we see a rapid move from 2D to 3D animation, low-end to high-end production technologies, limited in-house tools to cutting-edge animation production techniques such as motion capture and 3D character animation. In game formats, we see experimentation with multi-player games, cooperative strategies, and virtual reality. Interactive entertainment overall is a rapidly expanding area with a great requirement for creative intervention and sophisticated computer graphics. The videogame industry has only very recently come into focus for many people in the computer graphics field, yet this industry is now driving much of the technology development in computer animation.

Videogame development is being drawn deeper into the media mainstream. We have entered the age of the "commercial transmedia supersystem" where entertainment content is proliferated across multiple marketing opportunities: the game, the movie, the music CD, the book, the doll. Application developers have recently focused on an "author once, deploy many" imperative for cost effective production. As a new generation tackles the problem of interactive content production, their tools apply contemporary technical solutions to a process done with graph paper and assembler code not so many years ago.

Videogame content may evolve as well, driven by the new delivery systems which underly market growth. For example, the corporate dreams of interactive television list the two largest consumer revenue areas as shopping and (then) games. Ubiquitous interactive television would certainly leverage today's limited multi-user games. New audiences means designing for new cognitive models of fun and taking advantage of recent research in how media products relate to gender and childhood development. Electronic gaming could evolve to encompass nationwide social events such as elections, celebrity trials, virtual participation in natural disasters, and so forth.

All these new products, applications, and markets require technical, design, and artistic contributions for development, yet our skills, knowledge sets, and innovation must be translated into the new forms. To make this translation we must develop a coherent picture of how this industry is currently constituted and how it may evolve in the future. This panel will focus on a number of topics including platform hardware, delivery systems and their markets, the move into 3D computer graphics, virtuality in videogame design, overlapping areas of interactive entertainment, e.g. multimedia and theme parks, markets and content, and projected future developments.

Mark Stephen Pierce: Evolution of Game Content

The history of videogames spans less than a quarter century. Technology, design processes, and content have all been forced to evolve quickly and haphazardly over this period. Technological evolution has been the most consistently rapid, keeping production techniques unsettled. Content has evolved at the slowest pace.

In relation to the rest of the high-tech world, the videogame industry has been something of a paradox. Due to a broad consumer base, videogames enabled the personal computer age to get an early start with lower cost monitors, processors, and memory, making affordable PCs a reality in the 80's. But, at the same time videogames has been a major enabler of this technological revolution, it has also been considered a backwater fit only for hackers and bold, technologically capable artists who tolerated "jaggies" and tight content and performance restrictions.

Now, as we start the second quarter century, we in our backwater find everyone from Hollywood agents, large communications conglomerates, and high-end hardware producers at our doorstep telling us that our industry is about to go through a content revolution. Increased capabilities of delivery technology and dreams of large profits have convinced many newcomers that undiscovered territories of audience and content lie hidden in the uncharted interior of the games continent. We stand on the shore and wave "Hello" to the many newcomers rushing headlong into this entertainment arena armed with venture capital and buzzwords like VR, LBE's, HMD's, FMV, CD-ROM, "Doom Engines" and "Infotainment." While we hope they find the treasure they seek (More fun for us too!), they are in danger of ignoring the core issues of what has historically made for successful interactive entertainment product.

How will this drama play out? Will we indeed see the light, change our content and design for perhaps mythical markets or will they learn to love lucrative fighting games? Must we give up our drums and pagan idols and take up the new religion? Will they convert us or we them?

As an industry veteran, I would like to make these newcomers aware of the rich and humorous history of the medium they seek to conquer and change. And remember: Television ALSO could be a constructive societal enablement, but Oprah and her ilk still seem to be going strong. Perhaps Drive-and-Kill IS all we really want to do as an interactive entertainment consuming species!

Eugene P. Jarvis: Video Game Platform Technology from PONG to PHONG

The conflict between the quest for cool graphics vs. the lust for $$ has created the strange alchemy that drives video game platform technology. The early '70s saw the birth of the video game before the advent of the microprocessor or RAM or ROM. The platforms of this "Kill the Blip" era such as the immoral

"PONG" were based on hardwired SSI TTL logic. Colors were strictly black and white, and blips were any shape as long as it was square.

In the late 70's and early 80's the microprocessor came of age. Video game platforms sprouted MPU's and sprites, and bitmaps. "Space Invaders" in 16 colors on the Atari VCS was king in the "Kill the Martian" era. You could design anything you wanted as long as it fit in 256 bytes of RAM. The late 80's and early 90's brought 2D graphics technology to its greatest refinements in the "Kill the Human" era. Digitized 64 color graphics and multilayered backgrounds brought Mortal Kombat to full glory.

Today, the super nova of 3D, RISC, networking technologies and the prospect of Nintendo sized profits has created a feeding frenzy of corporate hype to stake out the new frontiers in interactive cyberspace. The merciless laws of consumer economics have crowned CD-ROM the winner, but which format? and where? PC (den), settop console (living room), arcade, or themed location (LBE)?

On the video technology front the battle is between full motion video (FMV) and real time rendering (RTR). FMV offers Oh, Wow! graphics with little or no interactivity for couch potatoes. RTR delivers incredible realism while demanding unlimited computing power. This is the classic confrontation between the Studio Weenies (content without interaction) and the Techies (interaction without content). When the vaporware clears, the Hollywood FMV scam will be left in the dust by hyper-reality based designs. Phong rules!

The golden age of On-Line Gaming is dawning as the richness of human-human interaction surmounts physical limitations. Networked multiplayer games with real-time audio and video links for interplayer communication are coming as technical barriers fall in the age of the Internet. The promise of VR will finally be realized as headset and rendering technology advances beyond the current barf-bag stage. VR peripherals will become ubiquitous plug-ins to consumer CD-ROM systems.

The only thing that remains constant is game theme in this new "Kill everything in 3D" era.

John N. Latta: Video Game Market Dynamics

The coin operated video game business is seen by many as a testing ground for new content, technology and the delivery of entertainment to the consumer. However, the market dynamics are racked with economic uncertainty, competition and a fickle customer. Increasingly, the consumer does not see the out-of-home video game as an isolated experience but as part of a continuum of where fun can be experienced. The market for video games can only be examined in the context of home video games, theme parks, urban entertainment centers, and personal computer games. This presentation will examine the forces which are shaping these markets both in terms of technology, the consumer and the business models. With this foundation, a wide range of issues will be explored which will shape the market in the future. These include: diversity of participation; cost of equipment and play; role of content development on multiple platforms; expenditure patterns for in-home and out-of-home entertainment; the development of new out-of-home play venues and the role of 3D technology in leveling the playing field.

Heidi Therese Dangelmaier: New Markets and New Game Paradigms

The existing types of video games were not born out of sterile market studies. They came to us in a more organic manner. Designer created types of play activities which allowed them to participate in their fantasies, activities which met their needs, or simply provided them a fun time. For those genres which have sustained, the needs and desires these genres addressed resonated meaning in many, and hence became archetype.

If we are to facilitate the development of new markets, we must recognize that the are many different types of fun, and what is a meaningful experience for one, may not hold any bearing in the value system of another. WE must eliminate the artistic exclusivity of this industry and allow room and opportunity for new artists, people intrinsically driven by different motives. We must not fool ourselves by believing that commercially market-driven projections will be our guiding light.

Only then, through an organic start, can we achieve the fundamental impact and attraction necessary to spawn a new movement of audiences. Only through a natural process will we identify the new archetypal interactive activities of the future... those activities which have the capacity to speak to the hearts, souls and desires of new audiences.

Jez San: Consumer Videogames Move into 3D Graphics

The early 2D consumer machines had the CPU do most of the pixel pushing, followed by sprite based machines moving hand-drawn 2D graphic objects with lightning speed and accuracy. Later, the 16-bit consoles from Nintendo and Sega had more colours, sprites, and backgrounds but games were still of the happy scrolly jumpy variety. Some were cute 3D hacks, but there was no real 3D capability until aftermarket rendering chips arrived. The 3D games around were highly playable but looked quite basic compared to regular scrolly games with hand-drawn artwork.

Then came the big PC guns, with their bags of CPU power, wads of memory, and correspondingly astronomical price tags. They did a pretty decent job rendering 3D graphics on the fly using software algorithms but now the new 3D games consoles have arrived in abundance with more to follow. These do fast texture mapping and shading in hardware allowing incredible 3D games to cover both food groups (look great, and play well) but the console companies are trying to keep them proprietary and incompatible.

What with 3D capability on both PCs and gameboxes the norm, it is time for games developers to bolster their 3D content creation capabilities by both learning new tools, and finding innovative ways to create content. All those hundreds of thousands of polygons per second need to be consumed by 3D games with interesting and curvy looking shapes that animate fluidly, and it is for this new market that the animation tool companies are now re-focussing their efforts (we assume their sales in the movie biz have flattened). In case you haven't already noticed, 3D Games are BIG BUSINESS.

Where does the new talent pool come from? Animators who can think in 3D are worth their weight in Onyxs. Any trick in the book to make the animators more productive should be considered, like Motion Capture allowing you to use real actors and stunt-dudes as reference animation, the way that people in the cartoon biz use rotoscoping only digital and in 3D.

3D games open up huge opportunities that were difficult to represent in those old fangled flat games, like having networked multi-players online at once with sophisticated character interaction, surrogate travel, virtual reality, you name it. All these things rely heavily on 3D real-time rendering and simulated worlds together with novel forms of input, like head tracking, pressure sensitive joysticks, more axes of freedom.

It's been said that there are really only four types of game, yet every traditional 2D game, from Pac-Man, Space Invaders, Donkey Kong, Pole Positon, Street Fighter can be revisited in 3D with new twists, concepts and imagination. It's about time we showed those developers of happy jumpy scrolly games a thing or two!

New Developments in Animation Production for Video Games

Chair
Jane Veeder, Time Warner Interactive

Panelists
Paul D. Lewis, Time Warner Interactive
Bob Zigado, Inter-Multi Studios
Robert Stein III, Trilobyte, Inc.
Craig Upson, Silicon Studio

Abstract
The booming videogame industry is currently making a dramatic move from modest, low end production techniques to state-of-the-art computer animation frontiers such as 3D character animation. Videogames is driving the development of new animation techniques such as motion capture and adapting cinematic production techniques as Hollywood and Silicon Valley merge. Through presentations and demonstrations by the midwives of these dramatic developments, animators, producers, and directors will gain practical insight about the special demands of videogames animation and how new production techniques are being developed and adapted.

Description
Interactive entertainment overall is a rapidly expanding area with a great requirement for creative intervention and sophisticated computer graphics: a good target for SIGGRAPH conference focus. Videogame development is the largest and most established component of the interactive entertainment field. The videogame industry has only very recently come into focus for many people in the computer graphics field and has certainly not figured much at all in SIGGRAPH venues and events. Yet, this industry is driving much of the technology development in computer animation.

The production segment of the SIGGRAPH audience will benefit from information about new animation production techniques being applied to this large job market. Why this special panel focusing on videogames and not just generic production show-and-tell on these topics? Because a) the application of existing techniques in videogames development requires major adaptations and b) videogames are driving the development of many new techniques and technologies.

Videogame production has all the complexity of linear-media animation production, but the animation must then interface with interactive software and be displayed in real-time on low cost platform hardware. Non-linear content presents different challenges than linear content. Platform hardware, whether arcade, consumer cartridge, or PC/CDROM, changes regularly and frequently. All these factors introduce additional and demanding requirements to animation design and execution which must be discussed within the context of videogame animation production to be understood. Here are some of the primary topics to be considered:

3D Graphics, 3D Character Animation, and Motion Capture - Videogame development is moving quickly from exclusively 2D into 3D computer graphics, from low-end to high end technologies, and from proprietary to production standard software. Low-end and limited only a couple of years ago, the videogames industry is emerging as a primary developer and user of motion capture and 3D character animation, both state-of-the-art computer animation techniques.

Evolution of Production Techniques and Animator Roles - How exactly were videogame graphics designed and produced in the past? As we work to define and master new production techniques and adapt them to videogames, how does the role of the animator change?

Adaptation of Cinematic and Special Effects Production Techniques - Inspired by market scale and encouraged by advances in data compression, Hollywood has turned to videogames as another publishing dimension and now, cinematic production techniques are now being adapted to videogames development.

Future of Interactive Entertainment Authoring - The demands of interactive entertainment media authoring and an increasingly competitive market are stimulating innovations in HOW such games designers and animators work. Reminiscent of the introduction in the 1980's of user interface toolkits and management systems, digital media development is embarking on an era of high level authoring environments, sophisticated assets management, and game prototyping environments.

Paul D. Lewis: Applying and Adapting High-End Computer FX Production Techniques to Videogames
Our current videogame projects have all the content development complexity of a high-end film FX facility, with a considerably reduced schedule and with the additional requirement to interface with interactive software in real-time display. The subject of my talk will be the problems and opportunities of combining these domains.

The videogame development process is different from that of conventional special effects in many ways and comparing the two is instructive. The development process for conventional media such as movies mirrors the resulting linear product. In the same way, the videogame development process mirrors the dynamic, non-linear, interactive resulting product. In film, you carve out a plan of what you want and fill it with work, but in coin-op videogame development someone (the market) is digging a trench that constantly changes depth and direction.

Film aims for a finely tuned product presented to a passive audience. The audience response may vary but the film is predictable. The character of a videogame changes based upon the player's participation. Content development for games requires producing not just the artwork for one path, but all of the possible paths allowed and how to transition smoothly between them all arbitrarily. The content development process for film is relatively well understood and established while game format and interaction, not to mention production techniques and platform capabilities, may change with each new product.

Content volume and schedule are other areas of contrast. A film action sequence might have 30 FX shots, where a typical fighting game will have 1200-1500 moves, or shots. Film production from concept to delivery might be 4 years or more, where game development cycles need to be 16 months or less to be cost effective and stay in tune with audience trends.

As different as film FX and videogame graphics production are, one of the primary challenges of the expanding field of "interactive entertainment" is to successfully combine them. There are many motivating factors. Videogames are subject to the movie and television trained audience expectations of photorealism, character expressiveness, and overall graphics sophistication and complexity. Production and delivery technologies as well as professional expertise are now migrating freely across all these linear and non-linear realms in response to market opportunities.

We embarked upon applying state-of-the art animation technology to videogame projects, only to discover that it needed to be expanded and extended yet further to meet our requirements. Some requirements were in the areas of shared databases and work practices, computer supported cooperative work, parallel distributed processing, prototyping pipelines, production tracking, and assets management.

Development flexibility is a key component. Building on the high-end to deliver to many different low-end platforms is one obvious but essential production translation. Equally essential, but perhaps not so obvious is the ability to make radical design changes during actual content creation. For example, a character may be largely redesigned based upon a weekends field test. Not planning for such flexibility can expand production schedules unexpectedly and miss market opportunities.

I will discuss and illustrate a number of the practical issues encountered in moving videogame animation into high-end 3D technologies. I will also contrast the design and production methodologies for 3D for 2D versus 3D for 3D character animation for videogame projects.

In addition to improving existing production techniques, the competitive nature of the videogame industry compels us to develop new animation and production technology as well. Designing flexible systems that can respond to future needs in a demanding market will contribute valuable tools to the interactive entertainment industry as a whole.

Bob Zigado: Breaking from Tradition in 3D Character Design for Videogames

The incorporation of 3D computer animated characters into videogames present opportunities for breaking with two burdensome traditions of character animation: the elastically exaggerated 2D cartoon character and the coldly perfect 3D computer animated character from the (by now) old rigid-body days. This opportunity is being afforded by the convergence of 3D computer animation, real-time polygon display platform technology, and the initial emergence of inverse kinematics in production-standard software – all fueled by a flurry of risk oriented, venture capital driven development of videogame titles. This much awaited opportunity is giving wings to the visions of many, heretofore marginalized, character animators.

Historically, my character designs were controversial when considered within the context of traditional, Disney-dominated character animation. Yet, the capabilities of rigid body 3D computer animation could only hint at the psychological interiority that my characters needed to communicate graphically. The new digital expressiveness combined with the Oedipal underpinnings of the lucrative electronic fighting game is providing the perfect theatre for a previously unavailable depth and intensity of game character-as-self.

Real-time polygon display hardware will, for the next 2-3 years, force us to display-what-we-mean using the minimum “physical” form of expression, i.e. minimal geometry. Making every polygon work for the visual message will not allow the squandering of real-time computational power upon gratuitous photorealistic effects that, while providing eye candy for the viewer, generally contribute nothing to meaning and frequently distract from it.

Robert Stein III: Case Histories in Developing Interactive Adventure Games

I will be presenting a brief history of the production tools and techniques from Trilobyte’s adventure games, “The 7th Guest,”and how they varied through the “11th Hour” to today with emphasis on surmounting file format incompatibilities, training 3D artists, beta testing tools, cross media integration and in-house compression.

In tandem with developing “The 7th Guest” and “11th Hour,” Trilobyte developed an in-house compression and authoring environment. Previous to this, our artists and designers were using mid-range 3D graphics and animation software for development but were limited in their ability to quickly prototype the final results - no control over playback speed except using scaled down or lower resolution images which then distorted that aspect of the product.

Our authoring environment, “groovie,” gives the artists and designers the ability to see the final sequences at either real-time playback speed and full color OR a frame playback speed and resolution emulating any of various game platforms, PC/CDROM or consumer, without having to wait for integration with final game programming. This authoring environment also produces final output by compositing graphics overlay with incoming video, embedding sound, and creating an executable file targeted for the platform hardware. I will be describing and illustrating how these new authoring tools have impacted design and production.

Craig Upson: Authoring Tools Futures

There are several factors shaping the development of media authoring tools for video games, among them are the following:

1. Console platform proliferation and confusion. Since several new consoles come to the market over the next year, the game developer is left with some risky decisions that can have enormous financial impact. Choosing which platform to author for is not obvious. Game developers desire to minimize their risk by authoring the same or similar game for several platforms at once. Frequently called the “holy grail of authoring,” multi-mastering of the same content and game logic is key to the strategy of several authoring tool efforts currently underway. How can multi-mastering work when the platforms are so different?

2. New Console hardware capabilities. Each console platform under development contains substantial 3D graphics functionality. Currently there are few authoring tools that address real time 3D graphics in any capacity. The new generation tools must treat real-time 3D as a first class citizen along with audio, images, sprites and movies - a goal that is difficult to achieve.

3. The emerging use of characters in interactive stories. This factor coupled with the next generation console’s ability to render is enabling a transition from indexing into precomputed media (movies) to on-the-fly rendering. While this leads to much more realistic visual representations, it causes tremendous complexities for the author - as well as the authoring tool developer.

4. Life-Like behavioral models. Consumers are beginning to expect characters with life-like behaviors. These characters require more than believable motion and articulation: they require complex inter-character relationships, autonomous actions and goal directed behavioral models. The repetitive, predictable characters’ days are numbered. How is it possible to breath life into a computer modeled character and how can the authoring system help?

5. Performance, Performance, Performance. Authoring tools have traditionally produced sluggish runtimes. Is it possible to use a higher level tool and still get acceptable performance?

These factors among others are defining the baseline functionality of authoring systems. In this talk we will present out perspective on the foundations of tools for game developers of the future.

Aesthetics & Tools in the Virtual Environment

Chair
Christian Greuel, Fakespace, Inc.

Panelists
Patrice Caire, Virtual Reality and Multimedia
Janine Cirincione, Cirincione + Ferraro
Perry Hoberman, Telepresence Research
Michael Scroggins, California Institute of the Arts

Christian Greuel

We hear the talk of endless technological revolutions. We are surrounded by high-tech gadgetry that does our bidding. Yet what does all of this magnificent machinery really offer us? Does progress in fact exist? And if so, what is it actually worth without substantial content?

This discussion panel is addressing the current state of aesthetics in the virtual environment by focusing on the roles that tools have played in artistic communities of the past and how virtual technologies will undoubtedly affect their future.

The beginning of history shows human beings using naturally-made pigments to draw images on cave walls, allowing them to represent their experiences to others. Through tomorrow's technology, we may find ourselves projecting our very thoughts into the space around us in order to do exactly the same. The purpose of the aesthetic action has and always will be to visualize ideas and to explore our environments using whatever devices are available.

Today we have increasingly powerful instruments, such as personal computer workstations, stereoscopic video displays and interactive software, to present artificially fabricated environments, popularly known as Virtual Reality. The technological elements are in place and we have begun our investigation into the latest and greatest form of artistic communication.

Virtual Reality promises artists the most exciting breakthrough for the creative process since the invention of motion pictures. Now at the dawn of an era of virtual arts, the first generations of tools wait patiently to tell us something that we don't already know.

But what message do they bring? Is there any passion here? High-end technology is not an end in itself. It merely represents the latest in a long list of tools that can be used for human expression. We have not come this far just to do cool computer tricks or sell vacant office space. There has been an unfortunate lack of artistic activity in cyberspace. We must focus on this cultural deficit and breathe life into the cold silicon void that we have created.

By considering the tools of Virtual Reality in a historical context of art and technology as they relate to the fabrication of simulated experience, this panel of active artists intends to provoke constructive thought amongst the virtual arts community, promote active exploration of experience as an art form and unlock doors to possible roads for our artistic travels throughout this age of cybernetics.

Patrice Caire

The type of work I am pursuing can be explained by example with a description of project called Cyberhead that I designed and managed. Caire's Cyberhead, a Virtual Reality installation, is a fully immersed interactive fly through a head reconstructed from Magnetic Resonance Imaging (MRI) data. This Virtual Reality journey runs on a Silicon Graphics Onyx Reality Engine2 in real time with texture maps using a Fakespace BOOM 2C as high-resolution stereoscopic viewing and navigating device. To build the world the Sense8 WorldToolKit software was used. 3D sound is generated in real-time by two Beachtrons from Crystal River.

Cyberhead was developed in the Virtual Reality Laboratory and the Artificial Intelligence Center of SRI International in collaboration with the Lucas MRS Center at Stanford University. Additional 3-D CAD models and animation were created at Colossal Pictures; Spectrum HoloByte; and by Cyberware. My principal collaborators included Harlyn Baker, Nat Bletter, Aron Bonar, Tamar Cohen, Gina Faber, Mark Ferneau, Paul Hemler, Lee Iverson, Andy Kopra, Lance Norskog, Tom Piantanida, Marc Scaparro, Pierre Vasseur.

My primary goals with Cyberhead were to create a rich, detailed virtual environment with convincing, high quality, real time, reality-based (MRI) visual images that were properly lit, smoothed, shaded, textured, and anti-aliased. Directional sound was an equally important part of this world and experience. The human interface was designed to be simple, non-intrusive, and suitable for use by the general public. In relation to the audience, the goal was to create an entertaining experience that would make users think about such issues as how we interpret and associate the information we receive from our environment.

My motivation in doing this work was to explore new presentation paradigms made possible by this technology. This work also had to address the problem of how to represent data which is not easy to represent; how to be immersed in, interact with, and navigate through, this kind of data; and finally make the process esthetically engaging and educational.

Janine Cirincione

From the Futurists to the Bauhaus, artists of the 20th C. have embraced new ideas and new technologies in an attempt to reach beyond mere aesthetic aims, and to help create the future. For one reason or another these movements have been superseded by other, more promising visions of the future. How do we keep interactivity from turning into yesterday's news as opposed to the important, rich, aesthetic medium it can be?

One way of doing this is to incorporate a healthy level of self-awareness and criticality into the artistic process. What can the medium do? By what standards should the new medium be judged? Is the work's essential meaning best expressed in this medium? Does the work fully exploit the medium's potential? My collaborative work in virtual reality addresses these and other questions.

The Imperial Message, designed in collaboration with Michael Ferraro and Brian D'Amato was created as part of the

1993-94 Artist-in-Residency Award at The Wexner Center for the Arts, at the Ohio State University in Columbus, Ohio. The work is a prototype for an interactive virtual-reality game—a new medium somewhere between architecture, film and game. The piece is loosely based on the Kafka parable of the same name which deals with the vast distance between the Emperor and the Individual. The Imperial Message attempts to extend this sense of scale to present inherent conflicts between the individual and the state and between the unspoken, secret "Law" and its corrupted representation.

Kafka's probing vision of bureaucracy, communications, authoritarian, legal and social structures in the formative stages of Imperial China relate directly to issues that we face today as we examine the "Utopia" of cyberspace.

Perry Hoberman

We live in an age in which technological paradigms shift about every half year. Almost every month seems to offer radically new media. Overnight, new standards are created and, suddenly, what was once exotic becomes merely commonplace (if it isn't totally forgotten).

This brings up many profound questions for working artists. Is this relentless change a permanent state of affairs, or are we witnessing the infancy of some new constellation of interactive media, one that will eventually (like the cinema) coalesce into something more lasting? Until then, how can we (and should we) keep up? Do we spend all our time learning to operate new hardware and software? How can we keep any critical distance at all when we are so close to our tools? And what happens to our work when the currently state-of-the-art hardware and software that it depends on have become obsolete? (Perhaps obsolescence itself has become a key category, one that needs to have its pejorative connotations reconsidered.)

For most of the recent history of technology, interactions between people and machines have been overwhelmingly monogamous - one user, one interface. Even the fantasy of total interconnectedness that drives the current mushrooming of the global network posits each and every user at home or work with their own terminal; and networked virtual reality is usually understood as requiring a head-mounted viewer for each participant. What implications does this have for the public display of artworks? And what happens when this one-to-one correspondence between person and machine is disrupted? Are there more robust models for interactive art, arrangements that allow for a simultaneous, fully realized experience for an unspecified number of people?

The twin dreams of immersion and interactivity have been with us for some time, but we have recently seen their possibilities vastly enriched with the advent of ever more powerful computer hardware and software. Concepts and ideas that could previously be only described can now be fully visualized and inhabited. What new kinds of artworks (if any) are made possible by these unprecedented capabilities? Will artists be put in the position of merely supplying content for this emerging medium? Or will they play an active role in actually defining the medium itself?

Michael Scroggins

VR technology offers many possibilities for transforming the practice of art; however, I would like to concentrate here on addressing a potential of great personal interest. The ability to shape temporal experience through the manipulation of a set of simultaneous and successive acoustic events is a power which sound producing instruments have afforded the aural composer/performer since pre-history. The development during the last decade of videographic devices capable of instantaneous generation and manipulation of absolute (or abstract) images has given the visual artist a similar power. In this decade, the rapid advancements being made in real-time computer graphics technology promise even more powerful visual instruments. My work in videographic animation extends a cinematic tradition which began in the twenties with visionary artists such as Oskar Fischinger, Viking Eggeling, and Walter Ruttmann. Like those pioneers of absolute cinema, I have aspired to the creation of a visual experience of purely formal means which —like absolute music— achieves affect through the architectonic structuring of basic elements. Aside from obvious disparities in how the organs of seeing and hearing are mapped onto the brain (and thus consciousness), absolute animation has differed from musical experience because of the isolating boundary of the frame. VR technology offers a means to dissolve that boundary. For the first time in history we may become as totally immersed in the field of visible radiation constituting synthetic image as in the ocean of air pressure constituting musical sound. Immersive VR will prove to be a great advance in the age-old search for an engaging art of pure movement.

Visualizing the Internet: Putting the User in the Driver's Seat

Chair
Nahum D. Gershon, The MITRE Corporation

Panelists
Bran Ferren, Walt Disney Imagineering
James Foley, Georgia Institute of Technology
Joseph Hardin, National Center for Supercomputing Applications
Frank Kappe, Graz University of Technology, Austria
William A. Ruh, The MITRE Corporation

Summary Description
Information is dispersed over many Internet resources and quite frequently, users feel lost, confused, and overwhelmed. The panel and the audience will discuss how advances in interactive computer graphics and visualization methods, software, and hardware could make the information distributed over the Internet more intuitively searchable, accessible, and easier to use by people from all walks of life and interests. This will enable the us to make full use of the Internet's information universe from our computers.

The audience and the public have been encouraged to submit samples of slides and video material illustrating effective, valuable, and user-oriented approaches to visualize the Internet.

Visualizing the Internet: Putting the User in the Driver's Seat

We live in an exciting time. Connecting numerous information-stuffed computers dispersed around the world has created an exciting universe of information. This information revolution has enabled us to explore this universe from our computers. However captivating, we still have a long way before the use of this information universe is easy and intuitive.

Information is dispersed in many sources over the Internet and at times users feel lost, confused, and overwhelmed (justifiably so). To find required information or to browse through information, users need nowadays to confront frustrating searches through arrays of user-debilitating menus and belligerent computer systems. Some of the remote sources are massive and once the user has got the information, he or she needs to browse through large amounts of text, data tables, and images. How should the user know where the sources of the relevant information reside, how to get them, and, once the sources are retrieved, how to get the relevant information from them?

The World Wide Web (WWW), developed at CERN, Switzerland, and Hyper-G, developed at Graz Univ. of Technology, allow the user through a set of menus to roam through information spaces of documents or images. Captivating browsers, such as NCSA Mosaic and also Harmony have transformed the process of getting information off these Internet distributed information systems. However, some major difficulties still remain.

Advances and experience in interactive computer graphics hardware and mass storage have created new possibilities for information navigation, retrieval, and access in which visualization and user interface (UI) could play a central role. The question is how to utilize these advances and experience to reduce these frustrations and lower the time and cost of navigating through the information dispersed over the Internet, finding specific information, and accessing it once found.

If we do not involve the users in designing the information highway and its interfaces, we will create useless information systems. As long as there is a human being sitting in the front of the screen, the user interface of the information highway needs to be user-oriented (UO), taking the user needs into account. To be able to do so, we need to understand

- How human beings perceive information visually
- How the human mind works when searching for unknown or known information. How it is similar to visual processes
- The medium of the computer and its associated visual display.

Additional difficulties and issues confronting the design of human interfaces to the Internet and other distributed information systems of the future are:

- Users come in many flavors. How do we create user interface, navigation, and search methods that will cater to users of many different kinds, levels of understanding, capabilities, and cultures
- Information representation has many views. Information representation is multifaceted and flexible and could be used to suit the user's needs.
- Information is abstract. There is not always a straightforward mapping between an abstract information space and the display physical space. This is a problem that graphic designers have been struggling with for generations. Appropriate visual organization could make the understanding of the processes contained in the information easier.
- How could information visualization transform the traditional methods of information navigation, retrieval, and access beyond the automation of a library process?
- Is there is a way to browse through information using a better interface than sequential menus?
- How to facilitate information organizations that are flexible and changeable (e.g., changing the links among documents, providing global and detailed views of the information)?
- What are efficient visual abstractions that speed visual perception and understanding? What is the role of experience and training?
- How to incorporate use semiautonomous agents with visualization processes to reduce the work load?

- How to maximize the user interaction with the system?

- What are the users' needs?

Nahum Gershon: Putting the User in Charge of the Information Space Using Visual Skills
One of the major problems of current information systems distributed over the Internet is that the information is rigidly put in place. Pieces of information are linked together in a rigid structure - no changes are allowed. However, these pieces of information could be related to each other in various ways depending on the application, problem, personal way of thinking and perception, or culture. For distributed information systems to be effective, they should allow each user to construct his or her own information space with links and associations (among pieces of information and whole documents and images) that fit the problem, application, or ways of thinking and perception.

Another major problem facing systems of today is that while surfing over the Internet, users often do not know where they are in information space and do not remember how they got there. In short, users are lost. One solution is to provide users with visual views of the information space promoting quick perception and understanding. The user can "jump" from one document to another by clicking the mouse button without the necessity to go back resource by resource.

Enabling the user to modify interactively the links among the documents and images using a visual display and to (visually) view the information space globally and locally have been implemented over the World Wide Web in a MITRE enhancement to NCSA Mosaic.

Bran Ferren: Who Cares About the Internet?
To succeed with the new wideband networks, we will have to deliver a spectrum of experiences that add value to our lives. This is a significant challenge in a world where the competition for one's time and attention is fierce. This promise of a unique and rich experience will not be fulfilled by movie rental, games, or "I Love Lucy" reruns. It will require the invention of entirely new communications and art forms that to date have eluded definition. When these creative and technical challenges can be met, it *will* change our lives. Perhaps even for the better.

Jim Foley: Visual Navigation Through the Internet
Navigating the Internet, AKA cruising the infobahn, bears almost no resemblance to navigating the real world. The Internet is a linguistic world; the real world is visual. When I drive from city to city, I have a visual tool, the road map, to help me find my way, aided by linguistic aids (road signs) along the way. The objective of our research is to make the information highway system more like the interstate highway system.

The panel presentation will draw both from work at Georgia Tech on visualization tools for the WWW [3] and for text retrieval, as well as on insights from a recent NSF-sponsored workshop on 'Research Issues for the WWW' which I organized and chaired.

The WWW is especially difficult to visualize in a meaningful way because there is essentially no meaningful metadata. Nevertheless, we have developed several ways of viewing and searching collections of web pages which deal with the "lost in hyperspace problem." Similarly, we have been developing new ways to visualize the results of free-text queries to better understand how well-formulated the query is, and to assist in its reformulation, if necessary.

More generally, a broad research agenda to facilitate visualizing the Internet will be described. It includes developing 'information road maps' based on what we know about how people navigate through spaces; incorporating more meaningful semantics into the WWW to drive the information road maps; improving information authoring tools so that the metadata needed to provide information road maps is more readily provided; and developing means to adapt Internet information for presentation on a variety of information appliances, ranging from video-enabled phones to personal digital assistants to set-top boxes to workstations.

Joseph Hardin: Navigation on the Web
In the last 18 months, hundreds of thousands of people have been introduced to hypermedia through World Wide Web browsers like NCSA Mosaic. These tools provide users with the ability to easily browse through the global online information mass by simply clicking on hyperlinks. An early addition to the textual hyperlink was the ability to map links to images or portions of images. Anything that could be placed in an image with a format like GIF could be made into a link or set of links. This resulted in a rapid blossoming of methods on the Web to provide people with visual signposts to online resources. Maps, pictures of buildings, images of floor plans, aerial views of cities all were put up on the Web and used as guides to a variety of subject domains. This portion of the panel will tour some of these examples of visual navigation on the Web, discussing the ways authors have utilized graphic navigation, and the advantages and limitations of current practices.

Frank Kappe: Browsing and Navigation Through Deep Hyperspace
One of the big issues in finding information in the Internet is what is known as the "lost in hyperspace" syndrome: users cannot get an overview, cannot find specific information, stumble over the same information again and again, cannot identify new and outdated information, cannot find out how much information there is on a given topic and how much of it has been seen, etc.

I can see three counter measures to deal with this problem: reasonable a-priori organization of information, advanced search facilities, and visual navigation aids. Based on my experience with Hyper-G, the distributed information system developed at Graz University of Technology, I have the strong feeling that a combination of the three approaches can significantly reduce the "lost in hyperspace" syndrome, and I propose to explore the usefulness of graphical navigation aids to the extent possible.

As in Hyper-G browsers, information could be displayed in overview and local maps showing the position of the current document with respect to a collection hierarchy. Users can "fly" over a 3-D hyperspace landscape of local map and search results (encoding numerous features of the objects matched, rather than just a one- dimensional list sorted by match score) looking for salient features, select interesting documents, etc. Usability tests will have to reveal whether these visualizations are really useful for end users or just gimmicks.

William A. Ruh: The Role of Graphics in Future Information Delivery Systems
Next generation information systems will be very different than those fielded today. The stimulus for change is the need for organizations to improve the exploitation of their corporate information assets as well as to effectively exploit the massive amounts of information available from external sources and integrate these two. This information is inherently different than the information around which today's systems are built. Current information systems are developed around the management of reasonably sized, highly structured, record information. New information systems will be built around the management of

massive, un- and semi-structured, multimedia information.

One of the four major issues that need to be addressed is the organization, retrieval and exploitation of this massive information base. Is current technology adequate for providing integrated retrieval tools on the user's desktop and organized access to large volumes of data? Can the system search a massive collection in a reasonable time and identify precisely the items of interest to the user?

Graphical, tailorable display of information will be critical to this next generation. Access devices will include hand held computers where there will be no keyboard and maybe even no visual display, only audio. Mapping between mediums and modes, understanding what is appropriate and when are all critical issues. This will require a multi-disciplinary approach for development of graphical applications and interfaces.

Afterword

Internet technology would not transform applications areas if users cannot use it easily and efficiently. Advances in methods, software, and hardware of computer graphics and visualization together with understanding of the needs of the users and application areas could enable us to make fuller use of the Internet's information universe.

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Algorithms and the Artist

Chair
Peter Beyls, St Lukas Art Institute, Brussels

Panelists
Stephen Bell, Bournemouth University
Brian Evans, Vanderbilt University
Jean-Pierre Hebert, independent artist
Ken Musgrave, George Washington University
Roman Verostko, Minneapolis College of Art and Design

Introduction
We address a number of problems related to viewing algorithms as the formulation of artistic statements. We analyze the nature of the algorithmic approach as opposed to direct physical action. Here are some of the basic questions that will be raised. Why do artists choose to express themselves indirectly, by way of formal descriptions of their ideas and what are the sources of inspiration for algorithmic activity. How does current algorithmic work relate to formal methods in an art-historical context. What is the relationship between paint systems and a pure algorithmic approach and is there a way to integrate both. What determines the beauty and effectiveness of an algorithm. What is the relationship between an algorithm and the nature of the physical results it produces i.e. how to externalize (materialize) algorithmic processes. What is the role of interaction in the development of algorithms. Do algorithms allow for progressive optimization or do they require fully preconceived ideas? Finally, and most pertinent, does computer programming force a focus on the surface component i.e. perceivable structure, or does it allow for the manipulation of deeper components such as meaning and emotion? We shall confront the algorithmic practice of the panelists and hope for strong audience interaction.

Stephen Bell: Algorithm
I am interested in producing work which is realized through engaging the audience in active physical participation. In a general sense it can be said that I have been producing work by proposing rules for the generation of images but leaving significant parameters open to change. The form of the work is defined by the limits imposed by the rules and the degree and manner of control over the parameters afforded to participants. An algorithm can perform a role in creative activity similar to that of any other constraint used in art practice; the self-imposed limits within which one works in order to free oneself to indulge in creative play and experiment and yet at the same time ensure our focussed and hence enhanced attention. It is in this way that I use algorithms in my work. As I have been using computer graphic workstations the rules are encapsulated in an appropriate computer programming language. Computers are very useful control devices and the programming languages which have been developed to determine how they behave are effective, if somewhat limited, in enabling one to describe rules for the interactive real-time generation of the kind of graphic images which I am interested in; Representations of the interactions of programmed automata with each other and the audience-participants. I would like to hope that we can interpret the word ALGORITHM in a relaxed way. It is our prerogative as humans, particularly as artists, to interpret language fuzzily, not to define the meaning of a word for eternity but to exploit its value in passing, in a dynamic interchange of ideas and notions with fellow humans in which it plays a significant yet ephemeral part. The word ALGORITHM in the context of the panel will, I hope, be as a catalyst for lively and diverse discussion rather than a straight-jacket. That is, after all, the value that I have found in using algorithms in art practice.

Brian Evans: The Catalytic Algorithm
With technology it is possible to manifest mathematical ideas as images, sounds, sculpture and even poetry. Artists in all media have found mathematical processes of value in their creative enterprise. These processes are often described using algorithms. An algorithm is nothing more than a recipe, a finite list of instructions. This recipe will have precise steps to follow, perhaps requiring some initial input (i.e. ingredients). The algorithm will have a desired outcome, and be considered effective if the outcome is achieved. A tasty apple pie is the result of one algorithm, an image or piece of music derived from a mathematical process, generated from a computer program, is another. In describing mathematical processes with algorithms, beauty and meaning can be discovered. Numbers are mapped into light and/or sound, and perceived through the senses as objects. It is the mathematical source of these works that has aesthetic worth. Algorithms, implemented on computers, make it possible for us to see and hear the beauty of mathematical processes. We can explore the inherent beauty of these abstract processes, logical, human-made constructs that initially seem to have meaning only because they can be used to predict natural phenomena. These are processes our culture exploits to myriad purposes, from predicting tomorrow's weather, to navigating and landing a jumbo jet. When we see a mathematical model visualized, perhaps a model of water resistance over the hull of a racing yacht, a chart of planetary motion, or even the abstract image of a Mandelbrot Set, are we looking at something that, in some metaphysical way exists? Or is the mathematics describing nothing more than an intellectual construct, and the images simply pretty, and sometimes inexplicably useful? Is meaning culturally attributed, or is mathematics meaningful and effective because it describes "grand truths?" We trust our lives on a daily basis to the effectiveness of these mathematical models. What is the basis of our faith? Why do we trust them? The algorithmic image or composition gives us something to see or hear and begin to ponder. Aesthetic experience isn't in the viewing or the listening, it's in the pondering. For me it reduces to a question of divine presence, a point of irresistible curiosity and a source of infinite wonder.

Jean-Pierre Hebert
I explore the creative power of algorithms.

Under the keen control of wit and taste algorithms can reveal order, beauty and truth to surprise our minds, please our

eyes and inspire our souls.

Without restraint, they can also mass-produce ugly and boring vulgarity as any other medium, only much faster and cheaper.

Thanks to GA and GP, algorithms themselves can be mass-produced too. Integrating wit and taste into fitness functions is an interesting project, raising myriads of sensitive issues.

Another interesting idea in line with 'Algorithms and the artist': why not establish 'the art of the art algorithm' as a new form of 'conceptual art'.

When will a flow chart, or ASCII code on paper or any other form of code be exhibited as art without showing what it can produce ? Then of course, Donald Knuth will run the show.

Obviously, computer generated art is rejected by the commercial art world. Why is algorithmic art similarly rejected by most computer artists?

Ken Musgrave: Formal Logic and Self-Expression

Determinism precludes free will. Artistic expression is perhaps the highest manifestation of free will. Yet artistic expression can be obtained strictly through the digital computer, which operates precisely in the real of formal logic, which in turn is the epitomy of deterministic reasoning. The creative act of self-expression directly through a computer program places in unique juxtaposition these mutually contradictory philosophical extrema. My own work entails mapping scientific models, based on the formal logic of mathematics, into the formal logic of computer programs, and using these programs to generate images which (I claim) represent artistic self-expression of a spiritual nature. This bizarre new creative process marks, I further claim, a greater discontinuity in the creative process than any other new medium or process in the history of the visual arts. It's deep and well-developed roots in the formal disciplines of math, science, and logic give it unprecedented conceptual depth. I propose to present, fortify, and defend these claims in this panel. In the process, I will highlight the serendipitous character of proceduralism in the process, the use of random fractal models in reproducing the kind of visual complexity typical of natural scenes, and the ramifications of the computer's returning representationalism to the "open problems" category in visual art.

Roman Verostko: Notes on algorithm and art

Almost as if by magic - whatever procedure you dream of - you can probably extend the power of your dream to the computer and let it develop the dream beyond your wildest expectations. You may identify procedures for improvising with color, scale, and position - which is what artists have always done. Given sufficient definition you could develop a form generator and from your new vantage point see new possibilities for further elaboration on your routine. Through trial and error - interacting with the algorithm itself you proceed further into the new frontier. So what can we learn from this? We learn what artists have always known - that "CAD" programs, paint brush programs, paint brushes and drawing paraphernalia do not make art. Neither do artists or designers simply "make art". The one over-riding essential element to the process, "a developed artistic procedure", is necessarily unique for each artist and for each work of art. The procedure addresses a singular conjunction of elements for which there is no "universal" rule. The "calculus of form" may be placed in the service of such procedures but should not be confused with the art-making procedure. For the artist who writes the code the artistic procedure is the act of "writing the code", pretty much like the creative work of the composer when the composer writes a musical score. Making art does indeed require a "calculus of form". But the artist's instructions on how to employ the "calculus of form" precede the "calculus". One needs an "artistic procedure" which addresses the entire complex of elements for each specific work. The final form, unique and specific to each work, embraces more than the "calculus". While it embraces and grows from a "calculus" it might employ any of an infinite number of approaches to deliver the form. These may include metaphor, improvisations of the form phenomenon in and of itself, or reference to some other phenomenon or idea - historical, literary, political, mathematical or philosophic. Can an artist write an algorithm then for an artistic procedure? Emphatically yes! Such algorithms provide the artist with self-organizing form generators which manifest his or her own artistic concerns and interests. We are looking to an interesting time ahead of us when artists will be able to exchange and interact with each other's form-generating tools in ways we never dreamed. There are procedures yet to be developed to make this kind of interactive expression accessible - a time ahead when we will literally see an evolution of form including a genealogy associated with its creators.

Peter Beyls: Algorithms for conceptual navigation

I have always thought of computers as dynamic tools for introspection, exploration and discovery. Computer programming is instrumental in the externalization of ideas and algorithms are formal descriptions of ones hypothesis of what constitutes the production of creative statements. The computer is a playground to speculate on the generative potential of ideas. As a matter of fact, the physical, tangible management of purely conceptual constructs becomes possible. However, the paradox is that while algorithmic specification allows the artist to touch the essence of his ideas it also creates a distance since all specification is indirect and seems to exclude spontaneous action. The idea is to view computers as partners in the process of creative decision making. By way of algorithms we can explore various man- machine relations in this partnership: from studying total autonomy in computer programs to systems designed for explicit interaction. The development of personal algorithms is the key to exploration and the gradual specification of objectives from incomplete knowledge, in sharp contrast to view the computer as a slave; as a medium for deterministic visualization. We have characterized the interactive method where man and machine collaborate in a common effort and with common objectives as conceptual navigation; the artist-programmer gets feedback, his expectations are confirmed or contradicted by the program's behavior. Eventually, unexpected results may signal new and promising routes exposing unknown territories. Thus, man and machine contribute both to the creation of a computational climate that favours invention and to the development of a critical attitude towards the often complex relationships between programmed intention and actual result. Writing algorithms has also forced us to evaluate experience vs. speculation. If one relies on models that have proven to be successful in the past, one confirms what is already known. Algorithms that use rules reflecting this knowledge produce predictable results. Otherwise, designing processes with the greatest possible freedom in pure speculation is like working outside of any known context, making evaluation very hard indeed. The creation of new contexts for growing algorithmic activity mixing memories of the past and an open imagination is, I think, perhaps the most interesting challenge to algorithmic art.

Performing Work within Virtual Environments

Chair
Henry Sowizral, Boeing Information and Support Services

Panelists
Ian G. Angus, Boeing Information and Support Services
Steven Bryson, CSC/NASA Ames Research Center
Stefan Haas, Fraunhofer Center of Research in Graphics
Mark R. Mine, University of North Carolina
Randy Pausch, University of Virginia

We can now use virtual environments to visualize fairly complex structures, to move around within those structures, and even grab objects and move them around. Now we need to discover how to work effectively within immersive environments. Experience to date indicates that we need to:

- Access or change environmental/system/meta parameters
  - Who designed this part?
  - Where am I?
  - Load the electrical system.
  - How do I change the lighting condition?
  - Make a notation.
  - Show me the isosurface originating at this point.
- Find or manipulate particular objects
  - Place me in front of the electrical panel
  - Change the couch's upholstery to a different fabric
- Perform analyses
  - Can I remove this part?
  - Do the wingtip vortices collide with the main body?
- Export changes to permanent storage

Ian G. Angus Boeing Information and Support Services
VR will remain inferior to the desktop as a serious work environment until users of VR can access the same data as available on the desktop.

VR promises users the ability to visualize and manipulate data in ways different or even more natural than possible on a flat screen display. However, unless users have access to all the data they need to make intelligent decisions, VR interfaces will only provide a partial solution, one that may in the end hamper rather than enhance users' ability to perform work.

The design and analysis process needs more information than just geometry. Design engineers need to access information such as text descriptions and 2D schematic graphics, and even programmatic information such as machine checkable design rules. Without access to such mundane information sources, a designer may find it difficult to perform a required task within VR.

Realistically, VR will not replace the workstation in the immediate future. Most VR users and especially those located in a design setting will spend a limited amount of time per day, perhaps only a few tens of minutes, in a VR environment. Most of the time these users will use a flat screen application to access the data they need. Requiring a whole new mode of data access just for use within the VR environment does not make sense, especially if the data more naturally fits within a flat screen paradigm.

We believe that one of the crucial challenges for virtual environments is allowing immersed users to access and manipulate all of their non-geometric data in a familiar manner.

To meet this challenge, we have a developed a mechanism for inserting new and even some existing flat screen applications into virtual environments. We display their window on a "virtual clipboard." Users hold the clipboard in their hand and control the application by any of several mechanisms, for example, by touching the application's virtual screen. To demonstrate the effectiveness of this capability we inserted the familiar "Mosaic" browser into our VR environment. Users can now access the entire World Wide Web from within VR in the same way as on they do from the desktop.

The virtual clipboard can also allow users to control the virtual environment's parameters, parameters not easily changed using physical metaphors, such as a user's location within the environment. While not a complete solution to the problems of performing work in a virtual environment, we believe the virtual clipboard or tools similar to it will provide critical support to future users of virtual environments.

Steven Bryson CSC/NASA Ames Research Center
Interaction between the user and objects in a virtual environment is a key to useful application. Little is understood, however, about how to usefully interact in three dimensions in ways that really help perform tasks. This problem is further compounded by the marginal accuracy of the tracking systems typically used to allow interaction. There are times when real-world metaphors are helpful and there are times when they are hinderances. Using the virtual windtunnel as an example, we will examine the various ways of approaching this problem. Various interaction options will be surveyed. We will stress the use of user studies in the determination of useful interaction techniques.

Stefan Haas: Fraunhofer Center of Research in Graphics
The feeling of being immersed distinguishes working in virtual environments from desktop-oriented working. New interaction techniques help exploring all three dimensions and enable a free orientation. Using virtual environments will change the way of using computers at least as much as graphical user interfaces did, as they enabled thousands of applications to be used easily in the last decade. But will virtual environments be able to run 2-D applications and make their usage as easy as it has been up to now.

Taking the complexity of some systems, e.g., CAD systems, which are sometimes still FORTRAN based (not quite ready to jump into the VR age). Even if the technical problem of embedding non-VR applications into VR environments can be solved it is still the question of how user will be able to work efficiently in button and text input environments.

Another approach for bringing the benefits of virtual environments to regular mouse-and-keyboard-users is to introduce collaborative working between text, gui and VR applications by transmitting what-is-done instead of how-it-is-done. By this way, immersed users can grab and objects which leads to the selection the associated CAD and FEM system of the other partners. Fraunhofer has several years of experience of working with real-time collaborative tools even across the atlantic. In the Virtual Prototyping project of Fraunhofer CRCG, these new way of working is applied to virtual environments as well as gui tools.

Practical experiences show the bilateral benefits for both users of virtual environments as well as gui-/text-based systems. The latter become experts, which can be contacted for specific questions, in which the standard work tools available in the virtual environment are not sufficient, e.g. in modeling, simulation or data conversion. This enhances the working in the virtual environment. Most of the standard tasks can be solved by few tools. Toolchests or personal servants can be metaphors for this out-of-few selection. Only in the case of dedicated tasks, e.g., changing the tangent vector of a NURBS surface in the dimension of the associated tolerances, another expert has to be contacted and can use his dedicated tools, no matter if text-, gui- or VR-based.

Mark R. Mine: University of North Carolina
Virtual Environments: Nice Place To Visit, But Would You Want To Work There?

Despite considerable promise there has been a surprising lack of real-world applications in the virtual world. Why? What is so hard about working in a virtual environment? While a great deal of research has been focused on technological limitations such as low resolution displays, limited tracking systems and end-to-end delays, some of the greatest difficulties facing virtual-environment application developers are conceptual rather than technological in nature. We are unfamiliar with this new medium we work in, unable to utilize its power and to compensate for its limitations.

Before the promise of virtual environments can be fully realized, we must endeavor to understand the benefits and limitations of working in the immersive domain. We must characterize the inherent differences between working immersed and working through-the-window. We must determine which tasks are helped by implementation in a virtual environment and which tasks are not. We must realize that many of the characteristics which give a virtual environment its power are also the source of its problems.

Direct manipulation, for example, allows people to naturally interact with objects by reaching out and grabbing them. The lack of haptic feedback and physical work surfaces in a virtual world, however, make it impossible to perform precise positioning tasks using direct manipulation. Furthermore, virtual environment systems lack alphanumeric input, the mechanism typically used for precise manipulation in through-the-window systems.

As another example, immersion within a virtual world means we can distribute controls (and other information) about the user. It also means, however, that these controls can be difficult to find in the virtual world. Even if visible, controls may obscure your view of the virtual environment or you may have to traverse the environment to reach them.

Does this mean there is no hope for virtual environments applications? No! We must, however, realize that not all applications are suited for the virtual world. We must be careful how we choose applications to migrate to the virtual world, focusing on applications which depend on the display of and interaction with three-dimensional, geometric information. We must avoid converting these applications into two-dimensions applications floating in three-space with no value added. To do this we must develop virtual environment interaction techniques such as Orbital mode or Worlds-in-Miniature which take into account the limitations of the virtual world; techniques which take advantage of the naturalness of virtual worlds interaction while at the same time extending this interaction in ways not possible in the real world.

Randy Pausch: University of Virginia

Our recent efforts has been in areas involving

- use of physical input prop devices
- use to two-handed input
- analysis of tasks where immersion via HMD makes a difference
- general purpose interaction techniques

We believe that the use of two hands, controlling physical input devices with mass and some small number of buttons (combined with voice input) will provide a large number of break-through interaction techniques. We have already produced novel interaction techniques for volume data visualization and navigation/locomotion using two-handed prop-based interfaces. To this end, we feel that the utility of formless (i.e. glove/gesture) input has been highly over-rated.

We have had moderate success in finding tasks where immersion via HMD can be shown to quantitatively improve task performance. However, we have had much greater success establishing that even when measured (timed) task performance is comparable, the user's confidence level in the result achieved is much higher in an immersive interface.

Standardisation – Opportunity or Constraint?

Chair
David Arnold, UEA, Norwich, UK

Panelists
Jack Bresenham, Winthrop University
Ken Brodlie, University of Leeds, UK and Rapporteur GKS-94
George S. Carson, President, GSC Associates, Inc. and Chairman, SC24
Jan "Yon" Hardenbergh, Oki Advanced Products
Paul van Binst, University of Brussels and President, EWOS
Andries van Dam, Brown University

Panel Summary
Who and what are standards for? Are standards there to protect users' investments and ease the design of working, integrated solutions or are they there to generate product opportunities for suppliers? Given enough confusion in the market place the effect is to turn standards into supplier's opportunity, at the expense of users' protection. Extensions, registrations, revisions, profiles, and levels of certification all conspire to confuse the situation. The pressure to adopt Publicly Available Specifications and the perceived advantages of "de facto" standards can undermine the protective intent of "de jure" standards.

This panel debates different attitudes to standards, often associated with different sides of the Atlantic, but also between standardiser, politician, supplier and user.

Concern over slow progress in ISO growing, but even concern is slow to take effect! Political pressure for change has never been stronger (for example at the recent CEC workshop on choosing standardisation policy - attended by 350+ delegates.

Proposed methods of standardisation often assume that fast-tracking PASs will produce a better result, more speedily, but ignore the lack of success of fast-tracking to date in the graphics area.

Related topics for discussion include:

1) Is conformance certification worth the cost?
2) Portability v Extensibility?
3) Upwards compatibility - how is/should existing investment in products be protected.
4) Should registered items be allowed as a way of bypassing standards?
5) How should profiling be used.
6) De facto v de jure standardisation.
7) Can/should fast-tracking PASs be made to work?

David B. Arnold
With extensive experience in ISO projects cited as successes (e.g. CGM) and as failures (e.g. CGI) I feel well able to comment upon the issues of timeliness and effectiveness of the ISO standards process. Whilst CGI has not been taken up as the foundation of a range of device independent graphics products, neither did X11 protocol achieve the status of formal standard. A great deal of expense and energy was expended upon both so why did both fail? CGI was produced almost exactly to the original timescales defined when the project first entered the ISO arena - but there were then too many stages to go through. X11 Protocol, I believe, failed as a project, since the de facto route had failed to pay sufficient attention to how it would fit the other standards around at the time and how it could be phrased in unambiguous language. There are lessons from both failures.

These lessons will require both the de facto and the de jure camps to recognise the potential for getting things wrong.

I believe that as panel chair it would be my role to explain some pitfalls and to outline the trends and pressures which seem to be driving the mechanisms for standardisation in particular directions. Many of these pressures are derived from historical failings; some are political pressures which are justified to an extent, but where the expectations of the solutions seem to be based on the false premise that standardisers are getting in the way of standardisation. In fact the reverse is normally true - standardisers are normally trying to get genuinely standard definitions - but the brief to find an unambiguous definition by consensus often means being asked to solve the wrong problem! The standardisers are frequently as frustrated by this as the critics.

Dr. Jack Bresenham
Like many things in life, standards can be helpful, hurtful, or even neutral & indifferent. Time & circumstance play a part. Quality and completeness play a part. Economic realities & jockeying for competitive position must always be recognised. Entrepreneurs, academicians, and corporate minions each have egos mixed with personal & business interests they pursue. People make standards so it is essential to see up-front who's playing and what is the pay-off coin each seeks.

IEEE 803 for Ethernet & Token Ring in the early 1980's helped consolidate LAN protocols and brought to the fore the physical layer abstraction. By contrast, CGI as the ISO 9636 Computer Graphics Interface (formerly known as VDI in its initial stage of a lengthy gestation) took so long and wandered so far that its final approval was viewed by many as a non-event. CGM the Computer Graphics Metafile and GKS the Graphics Kernel System have enjoyed some degree of success as has PHIGS. CORE & GINO never made it to an internationally approved status but did exert significant influence in graphics development. PostScript, GL, RENDERMAN, GOCA, PLOT10 and the like have been proprietary pseudo-standards or de facto specifications of major consequence. Large bodies deliberating at length, especially large committees of 'professional' standards setters or lobbyists known as consultants or system architects, can muddy most any useful technical endeavour. Active, front line practitioners who have real problems to solve are more likely to agree in a timely manner and come up with something practical than are those far removed from the development process or those with no actual product to deliver on deadline. The so-called Green Pages in the Design Summary Book for S/360, Token Ring in IEEE 803, IS0 9636 CGI, and spanned variable-length records in MFT/MVT support do offer some instructive examples as attempts to promulgate de facto & de

jure standards. It really boils down to timing, knowledge, motivation, economics, and a goodly measure of common sense.

Ken Brodlie: Should we standardise and if so how?

Enthusiasm for graphics standards was high in the early 80s, with GKS and CGM defined, and a 3D standard in prospect. Now the ISO process is in competition with faster ways of creating "standards"- for example OpenGL, created as a proprietary specification, and later made available to a consortium.

It is now a good time to evaluate the two approaches. The ISO process has a number of positive characteristics; international; consensus; publication only when mature; but some negative ones; voluntary effort and staccato progress.

The proprietary approach has two flavours: in one, control of the specification is handed over to a consortium including the originator who does not have a veto; in the other, the originator retains control - "open" with a small "o"!

Both are valid approaches, but what sort of standard world do you wish to live in? I am for the democratic ISO process, so that the user voice can be heard. Some specifics:

(1) Conformance. Creating a test suite is fine, but running a certification process something else. Test suites should be made available for self-testing; governments should decide if they want a certification service, and, if so, need to back it up with legislation.

(2) Extensibility. Originally I felt that extensibility should be forbidden (as only sure way of ensuring portability) but this has mellowed to "the system should flag any extensions, in a health warning".

(3) Upwards compatibility. In recent revision of GKS to GKS-95, the twin aims have been to protect the legacy code, but also to go forward in a way which will bring back its old following amongst the user community, attract new users, and persuade suppliers there is a market for implementations.

Dr. George S. Carson

Standards have a time and place in the cycle of technology. This can be explained using a familiar bell-shaped curve showing the stages in the evolution of a technology. This explains where standards belong and the pitfalls of standardising too early or too late.

There are historical problems with formal standards. These include: standards that take too long (CGI); standards that ignore the marketplace, producing solutions that are not sufficiently differentiated from competitive ones to survive (OSI vs Internet); and standards that try to drive the market to a point solution where greater diversity is better (contrast LAN standards (diverse) with graphics standards (point solutions)). Diversity can be understood in the context of graphical file exchange formats, where the single ISO computer graphics standard is little used, while several platform-dependent formats predominate. Both the length of a development effort and diversity of solutions may be understood in terms of the consensus-building process.

Vendors and users have different attitudes about standards. Vendors desire rubber stamping of their technologies. The abortive attempt to standardize the X Window System is a good example. Users want openness (the ability to influence the content of standards) and long term stability (especially to influence the evolution of the standard.)

A new process being used by ISO/IEC JTC1 ISO PAS will make it far easier to adopt de-facto solutions (now called "Publically Available Specifications") as ISO standards without traditional consensus or technical review. This new process may significantly affect the quality of some future ISO standards.

I believe that better management of the standards development process, and not a set of totally new procedures that bypass traditional standards development, is the answer to the problems I have described.

Jan "Yon" Hardenbergh

Standards for computer graphics and multimedia come in three flavors: APIs (Application Programming Interfaces), file formats, and protocols. Each of these have direct beneficiaries and downstream beneficiaries. Standards influence everyone, willingly or not. The question is how to judge the success of a standard, and how to make standards more successful.

A successful standard makes it easier for many people to get better work done faster. Good APIs make it easier to create richer tools. Good file formats proliferate of high quality documents.

A good standard combines politics, religion and even a little bit of technology. It should target a constituency and focus to please them. A successful standard also needs financial support to make it easy to use and easy to notice. PHIGS, PEX, OpenGL have each had a measure of success in the 3D graphics market. Each had a very different process.

A good standard comes with a sample implementation and a test suite. It is critical that a software API have common header files across implementations, better if the actual API library code is common. This was a severe problem with PHIGS; each vendor had a different version of the API - sometimes based on different drafts of the emerging standard. The ideal standard needs to emerge early enough in the technology curve to shape everyone's opinion on what the "right" way to do things is. This gives it a religious component (based on quality technology). There is a brief time when the definition of the technology is still malleable and could become formal standard. The industry should treat a new technology like a crisis and iterate through periods of definition and prototyping.

Paul van Binst

The standardisation process in the field of Information and Communication Technology (ICT) has definitely been in need of reassessment for a little while. ISO, IEC and ITU at world level, CEN, CENELEC and ETSI in Europe are not "what they used to be" anymore in front of the waves of "de facto" standards or "publicly available specifications". The role of Governments and of the European Commission in the standardisation process is also often questioned.

Being the chairman of the Steering Committee of EWOS (the European Workshop for Open Systems) puts me in the particular position of playing simultaneously inside and outside the standardisation process; indeed, as a University Professor heading a department of "Telematics and Communication" I am by no means a professional standardiser while chairing EWOS definitely puts me in the middle of the standardisation process.

EWOS, a workshop originally associated with CEN to do the profiling of OSI standards, has seen its role and scope considerably enlarged over the years. Today, it is one of the very few standards related institutions addressing directly the hot issues such as interoperability between de jure and Internet standards for instance, and doing this on a global scale by our relations with our American and Asian counterparts.

A profound analysis of the ICT standardisation process is presently going on in Europe and it is expected that EWOS will play an expanded - and more market oriented - role in the future. This panel will be a chance to review the situation in the European and worldwide contexts.

Andries van Dam, Brown University

Graphics standards efforts started with de facto standards in the sixties and early seventies (Calcomp, PLOT-10, GINO from the Cambridge CAD Center, GPGS from Nijmegen, Delft, and Cambridge Universities), then committee standards in the mid-seventies (SIGGRAPH Core, Germany's GKS) and then "official" standards (ANSI/ISO GKS, PHIGS, PHIGS+). Today we have de facto standards (e.g., Adobe PostScript, Apple QuickDraw, AutoDesk/Ithaca Software HOOPS, SGI Open GL and Open Inventor, Microsoft GDI and DDI, X Consortium Xlib/ Xt/PEX, and Pixar RenderMan) which are commercially far more important and influential than official standards. Contrast this to the impact of, say, the IEEE floating point standard. Meanwhile, hot new 3D graphics libraries specialized for games are appearing (e.g., Microsoft/RenderMorphics Reality Lab, Canon/Criterion RenderWare) and will be rapidly disseminated in the personal computer space.

Given this situation, is it still relevant and useful to have cumbersome, multi-year standards efforts engaged in by committees whose members belong to competing techno-political-national factions? I will try to answer this rhetorical question in my role as cynic, i.e., as a frustrated idealist who believed in the value of standards bodies and efforts, despite all their built-in handicaps.

Some Background Material and Reference Lists

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Cross-Media Authoring

Chair
Jeff Martin, Apple Computer, Inc.

Panelists
Allejandro Villarroel, Cole and Weber
Chris Gulker, Hearst Newspapers
Rick Capps, Capps Studios Ltd.
Rick Smolan, Against All Odds Productions

Abstract
Today's world has become very media-centric: multimedia, print media, and now, of course, new media. However, with this panel of authors, entertainers, and publishers, it becomes clear that the message does indeed come before the medium, so content comes before context. The panlists show how messages should not be created for media vehicles in isolation, but rather should "cross the media" from video to print, and CD to online, delivering a core or graphics message in concert. The panel examines several questions: What is this new expertise of cross-media authoring? What is the creative and career proposition for its authors? What are the tools or transfer agents for crossing media without compromising quality? How do authors implement a unified design strategy while realizing the unique opportunities of each medium?

Grids, Guys and Gals: Are you oppressed by the Cartesian Coordinate System?

Chair
Greg Garvey

Panelists
Brenda Laurel, Interval Research
Rob Tow, Interval Research
Joan Staveley
Allucquere Rosanne Stone (a.k.a Sandy Stone), The University of Texas at Austin

Summary
This panel will address issues of gender differences regarding computer technology in general and computer graphics in particular by examining and debating the question first raised at SIGGRAPH 93: is the Cartesian Coordinate System oppressive?

Panel Topic Description
Grids, Guys and Gals: Are you oppressed by the Cartesian Coordinate System? examined the very real and palpable issues of gender differences regarding computer technology in general and computer graphics in particular. This panel brought to the SIGGRAPH audience the ongoing debate in the classroom, academic journals, and the popular press regarding significant differences between men and women especially in learning, using, and designing technology. Research points to measurable gender differences involving spatial cognition that may well contribute to the formation of social and cultural norms. Issues of gender and technology linked even to a discussion of identity are no longer seen as irrelevant to such practical concerns as the design of the user interface, input devices and visualization tools.

Many of the women and men who utilize computer technology are legitimately engaged in a critical appraisal of their role in the technological and scientific order. There is much to be gained by challenging certain assumptions, examining and critiquing gendered constructions of space or the interface and proposing alternatives (a feminist computer?, non-Euclidean computer graphics?). It reflects the will to transform and remake technology that is responsive to the range of human capabilities, limitations, needs and desires.

In many ways, Joan Staveley, artist and agent provocateur is responsible for the existence of this panel. At SIGGRAPH 93 during the NANOSEX Panel her remark encapsulated the issues at hand. The statement that the Cartesian Coordinate System is oppressive refers directly to the constraints of the tools and is of utmost importance because only by criticizing our current tools and seeing the limitations then can better models of the user interface can be developed. Her statement of course reaches much further in daring to suggest there are shortcomings to Cartesian rationalism.

However it would be a mistake to reject this view as that of a 20th-century Luddite. As an artist she is demanding more of the tools and seeking to reveal the barriers and biases that are only reluctantly acknowledged in what was a previously male dominated field. The near future promises a continuing transformation of this field as women increasingly play a more prominent role.

OSMOSE is a new work by Montreal based artist Char Davies, supported by SOFTIMAGE-Microsoft that confronts the limitations of Cartesian Rationalism. Davies, formerly a painter, is well-known for her series of large-scale lightboxes of still images created on SOFTIMAGE which explored metaphorical aspects of Nature with an aesthetic which was rich, multi-layered and ambiguous. OSMOSE continues this research, bringing it into fully-immersive and interactive virtual space. As in Davies' previous work, OSMOSE's visual aesthetic deliberately circumvents the Cartesian coordinate system (i.e. static, solid, hard-edged objects in empty space) to create spatially-complex and ambiguous relationships whereby distinctions between figure and ground, interior and exterior are dissolved. Similarly, the project's interactive aesthetic seeks to subvert the Cartesian privileging of mind over matter by grounding the immersive experience in the participant's own interior bodily processes thereby re-affirming the presence of the body in virtual space. In addition, interaction is designed to transcend the Cartesian dualism of subject and object by emphasizing mutual inter-relationship between self and "others", and encouraging behaviour based on gentleness and sensitivity rather than domination and control. At the direction of the artist, programmers at SOFTIMAGE are developing tools to achieve these goals and liberate the medium of VR from the cultural values of the Cartesian grid. Phase one of the project will be exhibited at the Montreal Museum of Contemporary Art for six weeks this summer in conjunction with the Sixth International Symposium on Electronic Arts, and will be exhibited in New York City later in the fall of 1995.

Other contributors to this panel examine the importance of spatial representation and links to cognition. Brenda Laurel: Artist, Author, and Researcher at Interval Research, Palo Alto, CA writes:

> "How space is represented in art, science, religion, and other cultural domains reveals much about the nature of a culture and transmits a variety of loaded understandings to its individual members. In turn, differences in experience and interpretation among individuals and subcultural groups reciprocally influence the larger cultural constructions of spatiality as both metaphor and practice. How we shape and employ spatial representations, metaphors and narratives in the construction of interactive media has enormous influence on who will experience our work, how it will be integrated and interpreted, and what its political ramifications might be. These considerations are especially relevant as regards both cultural and biological aspects of gender."

Brenda's colleague Rob Tow research scientist at Interval Research adds: "There are many representations of spatial relationships in human culture, art, and science, both now and through history. All are abstracted tools of knowing embedded in

particular situations, and all work better for some people than for others. Rectilinear coordinate systems, and their close cousin Renaissance perspective, are examples. Recognizing these differences, we should NOT strive for the mediocre ideal of some sort of androgyny of geometry, but must instead build instrumentalities and interfaces that are richly multimodal in the way they empower people who are differently endowed."

Allucquere Rosanne Stone a.k.a Sandy Stone: Professor, author, at the University of Texas at Austin joins the fray with:

> "PUTTING DESCARTES BEFORE DESHORSES...:Or, is the Cartesian system's relationship to gender a cause or an effect? The Cartesian coordinate system didn't spring intact from the brow of Rene; it arose in complex interaction with its social contexts. Other changes were in the wind too, and a lopsided gender binarism was just one of them. Stay tuned for a quick trip down mammary lane..."

This panel is also informed by the ongoing debate regarding significant differences between men and women especially in learning, using, and designing technology as part of a more general discussion of what is sometimes termed "cultural studies." One such view is that the edifice of western science and technology is but only a 'constructed' artifact of the dominant white male patriarchy driven by the imperatives of expansionist monopoly capitalism.

Examining this view in some detail reveals how moral and ethical concerns are extracted from a seemingly innocent and innocuous coordinate system. The Cartesian Co-ordinate System is seen to be a construct that paves over, subdues and silences the natural but raucous, unruly, diversity with the steamroller of reason. The Panoptic Cartesian Grid extended by projective geometry casts its net of domination over all that is observed, surveyed and measured. The convention of perspective at the service of the male gaze is a phallic instrument that penetrates the visible world of nature. Today many of us, male and female would recoil from the words of Francis Bacon, a white male and father of the enlightenment when he recommends that nature(female) is to be "hounded in her wanderings" "put into constraint," "bound into service," and made a "slave." [1]

In spite of claims of objectivity modern science is apparently not so innocent. In "The Science Question in Feminism," Sandra Harding [2] writes:

> "...science today serves primarily regressive social tendencies; and that the social structure of science, many of its applications and technologies, its modes of defining research problems and designing experiments, its ways of constructing and conferring meanings are not only sexist but also racist, classist, and culturally coercive."

Similar lines of argument assert that the rise of modern science founded on domination and possession is coupled with the development of capital and private property. From this perspective Descartes' Coordinate System is seen as a tool that merely facilitated for example mapping the globe at the service of colonial exploitation.

However Marshall McLuhan puts the blame on Gutenburg:

> "The same Gutenburg fact of uniform, continuous, and indefinitely repeatable bits inspired also the related concept of the infinitesimal calculus, by which it became possible to translate any kind of tricky space into the straight the flat the uniform and the 'rational'. This concept of infinity was not imposed upon us by logic. It was a gift of Gutenburg. So, also later on, was the industrial assembly line. The power to translate knowledge into mechanical production by the breaking up of any process into fragmented aspects to be place in a lineal sequence, yet uniform, parts was the formal essence of the printing press." [3]

McLuhan continues by connecting Gutenburg to the exploitation of both humans, animals and the environment that follows from the admonitions of Bacon: "The breaking up of every kind of experience into uniform units in order to produce faster action and change of form (applied knowledge) has been the secret of western power over man and nature alike." [4]

We should give credit where credit is due because one of Descartes' primary contributions is his analytical method of breaking a problem down into pieces and putting them into a logical order. This method is at the service of the familiar imperative of the enlightenment project: the domination and transformation of unruly nature by reason. The opposition of man alienated from nature also happens to be the classic Marxist dialectic – Man must appropriate and dominate nature through analysis and praxis in order to realize his humanness. This inevitably leads to moral judgement and revolutionary self righteousness. From a completely different direction John Ralston Saul in his turgid sweeping indictment, "Voltaire's Bastards" convicts the enlightenment faith in unbridled rationalism by condemning it for training a generation of amoral, irresponsible, and all too often destructive rational elites. [5]

At this point it may be appropriate to heed Foucault's admonishment: "In any case, I think that, just as we must free ourselves from the intellectual blackmail of 'being for or against the Enlightenment,' we must escape from the historical and moral confusionism that mixes the theme of humanism with the question of the Enlightenment." [6]

Descartes' search for a method of analytical doubt led to his partition of mind and matter. God Himself is seen to have created nature as a mathematical machine and was the necessary source of the light of reason that enabled the human mind to perceive this order. The 19th century mathematician Leopold Kronechker held to this with the declaration that "God made the integers; all else is the work of man." [7] Yet God's position as the guarantor of reason was not eternal. The reductionism of Descartes drove Bertrand Russell to this inevitable conclusion:

> "I shared with Frege a belief in the Platonic reality of numbers which, in my imagination, peopled the timeless realm of Being. It was a comforting faith, which I later abandoned with regret. In the end it seemed to result that none of the raw material of the world has smooth logical properties, but that whatever appears to have such properties is constructed artificially in order to half them." [8]

Russell clearly acknowledges that the net of reason constructs its own artificial reality by attempting to ensnare the natural world. Even Albert Einstein remarked that the integers are "obviously an invention of the Human Mind, a self-created tool which simplifies the ordering of certain sensory experience." [9] So in the words of an arbitrary selection of major male architects of the edifice of the math and science-it's all an artificial reality. But as Chomsky might ask: "Who benefits?"

The answer to this question may be found in the artificiality of internet cross dressing or gender/identity aliasing. Kevin Kelly points out the peculiar phenomenon of gender bias of player's of on-line interactive games. "So many female present-

ing characters are actually males" "Players now assume all players to be male unless proven otherwise. This has led to a weird prejudice against true female players who are subject to the harassment of proving their gender." [10] Alan Turing anticipated the contemporary gender clash on the net with the imitation game-the so-called Turing Test for artificial intelligence where: "The object of the game for the interrogator is to determine which of the other two is the man and which is the woman." [11]

In her article "The Men's Club Is Now Closed" available through Gopher, Stacy Horn writes passionately on what it's like for a woman on-line. Some relevant excerpts follow:

> "There are gender differences on the net, of course, regardless of the proliferation of bad metaphors. The on-line world is often touted as a bodiless medium. As The New Yorker magazine put it, in a drawing of a dog typing at a computer: "On the Internet no one knows you're a dog." Nonsense. The illusion of free and unbiased communication can only be maintained, and then only briefly, as long as people hide. It's a trick. If no one knows you are a woman, until that is discovered then you will not be treated like a woman." The only way to be treated equally is by going under cover? No, thanks. I want to be in your face, I don't want to be a man on-line or otherwise."
>
> Is the men's club sustained by a grid of innate and/or learned behavioral norms? Do male occipital lobes incorporate a wetware coding of the ready-to-wear Cartesian coordinate system maintained by a steady influx of testosterone? As the Wall Street Journal reports is the popularity of Tetris among women explicable by a drive for (Cartesian?) order based on the nesting instinct and rewarded with a flood of endorphins? Is it the case that (male?) metaphors such as the electronic frontier or information superhighway simply do not capture the true nature of the on-line experience? Stacy Horn suggests "the word 'infrastructure' invokes the idea of a web or a tapestry, a metaphor which allows for infinite color, texture and variety."

Ada Lovelace is credited with being Charles Babbage's Muse and with providing inspiration for his analytical engine of punched cards. If the Jacquard Loom is seen as the progenitor of mechanical computation marking the beginning of the age of computing, could not La Dentellerie or lace making be a more apt metaphor for the net? Was weaving itself – a woman's task – the unacknowledged inspiration for Descartes' grid?

In spite of the rants, raves, and the loss of the thread of meaning through a welter of deconstructed text, the seemingly neutered grid remains indifferent, implacable and maintains a periodic refresh and panoptic sway over mind and raster graphics.

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Visual Effects Technology – Do We Have Any?

Chair
Derek Spears, Cinesite Digital Film Center

Panelists
Scott Dyer, Windlight Studios, Inc.
George Joblove, R/GA-LA
Charlie Gibson, Rhythm & Hues Studios
Lincoln Hu, Industrial Light & Magic

Introduction

Derek Spears
This panel is focused on taking a look at what key technologies we need to push visual effects father into the realms of realism. We will start by examining what tools we have used so far in order to provide a firm reference to understand where we are going. Tools in the areas of Input/Output (Scanning/Recording/ Data Transfer), Image Processing, and Animation/Motion Capture will be covered. These are not only major concerns for the visual effects industry, but cover large areas of interest for mainstream computer graphics.

Why is this important? The visual effects industry as a whole has become in and of itself a proving ground for cutting edge digital technologies. Morphing, Motion Capture and Digital Compositing were largely born out of the needs of the Visual Effects industry and Visual Effects has benefited enormously from advances in Computer Graphics. This is partially due to the Visual Effects Industry's willingness to embrace new technologies, riding the bleeding edge. These technologies have enabled us to do things never before imaginable.

While we all think that the quality of visual effects has been stunning in the past, we need to stop and look at how we really achieve these images. The tools obviously work, we have produced breathtaking imagery with them. But we have to ask the questions "Are they good enough? What more do we need?" These questions relate not only to the search for solutions to previously impossible problems, but also the search to do things we already understand better, faster and cheaper. The search for new technology includes advances in algorithms, totally new approaches, and even solving more basic and historically ignored problems, such as user interfaces and artist interaction. We will take a look at our present and a glimpse into our future of where our tools are (and more importantly, should be) headed.

Panelists Summaries

Scott Dyer
The technology behind the creation of convincing computer animation is changing on an almost daily basis. While the early days were dominated by purely technical achievements that often lacked sophistication, today's achievements are visually stunning as well as being grounded in good stories, characters, and situations. Technology is no longer an end unto itself; it is often used invisibly to aid the story without undue attention. It is this new emphasis, I think, that has allowed computer animation to move into the mainstream without fanfare (or objection).

While computer animation technology continues to move forward on a variety of fronts, Windlight has chosen to concentrate on motion capture as a mechanism to enable inexpensive high quality long format production. Now that the novelty of motion capture has worn off, and many of the myths have been debunked, we believe the industry will gradually apply motion capture increasingly but only where it is appropriate. Motion capture isn't a solution to animation; it is simply another tool.

How motion capture data is mapped from an actor to an arbitrary character is of great interest to Windlight; the use of this technology on non-human figures has been significantly less successful than its use in human animation. There is also a lot of interest in the joining of motion capture sequences (using some underlying biomechanical model) so that the promise of "clip" animation could be realized. The impact of these developments on the highest end animation isn't clear, but they are of great importance in the television and video games markets.

The larger question, though, is not just about motion capture but about how "performance" animation can be better used as a timing and animation tool. Computer animation has generally been a slow, quiet process done in private and performance capabilities can open new doors on providing interactivity and participation in the process. Windlight is actively pursuing these areas as ways to increase the quality of our animation and to take better advantage of the experience of our animators.

George Joblove
The presentation will discuss the use of image processing and compositing as visual-effects tools. We will begin with a brief introduction to the problem: how compositing is the basic operator of visual effects, and why it is so important. For perspective, we will review how it was done before computers, and why it continued to be done that way for so long after computers, and look at the fundamental technology that digital manipulation requires. The kinds of capabilities that currently form the basis for such systems will be discussed, such as color correction, framing, filtering, matte extraction, compositing, and others. Then we will discuss the importance of this technology, the need for more development in this area, and some ideas for new tools. The importance of tools that provide the effects artist with power without impeding his creative input, and the need for keeping the artist in the loop, will be stressed.

Charlie Gibson
We have seen amazing growth in the digital imagery market in combination with feature films. With respect to Feature Visual Effects, our studio chooses to focus on two trendy and highly visible forms of digital technology. The first is compositing and image manipulation, in which digitized imagery is mixed together, manipulated or cut-and-pasted with other digitized imagery. The second is photorealistic image synthesis, which involves creating "realistic"-looking imagery from scratch in the computer (usually characters, environments or vehicles). This

process is simply not yet easy enough. The technology and algorithms for creating the basic imagery are there, but the user interface paradigms are just not keeping up.

The talent pool in this industry is very nearly drained. There is more work out there than there are qualified people. Rather than training people to perform under unnecessarily arcane and complex UI systema, I would like to see a complete rethink on the current user interfaces for 2-D and 3-D computer graphics. Computers are going to get even faster and cheaper in the future. With the promise of complex image analysis, procedural and physical simulation tools coming into the realtime relm, we should really think about the way that we work with computers when producing visuals of any kind. We will also need a clever way to wrangle scenes of very high complexity! In the case of photorealism, complex detail is the most important component of the mix. We still bump up against hardware and software limitations every single day in production.

Lincoln Hu

Successful visual effects often depend on the careful manipulation and seamless integration of elements with live action background environments. Over the last few years, many practitioners in this field have developed interesting techniques to help produce these visual effects. We will take a look at some of the underlying technologies that were developed, including the work in imaging, computing hardware, network, I/O, and user interfaces. In addition, we can also take a brief look at some of the developments in 2D and 3D computer graphics tools in painting, image warping, digital compositing, image processing, modeling, animation and rendering, and examine how these tools have been used in the production of feature film visual effects at Industrial Light & Magic. We will also discuss some possible directions for future development in these areas.

3D Graphics through the Internet – a "Shoot-Out"

Honorary Chair
Carl Machover, Machover Associates Corporation

Panelists
Gavin Bell, Silicon Graphics
Tamara Munzner, Geometry Center, University of Minnesota
Fabio Pettinati, Apple Computer
Val Watson (organizer), NASA Ames Research Center

3D graphics through the Internet needs to move beyond the current lowest common denominator of pre-computed movies because these movies excessively consume bandwidth and are non-interactive. Panelists will demonstrate and compare new approaches for accessing, analyzing, and collaborating on 3D graphical information through the Internet and World-Wide Web. This "shoot-out" will illustrate which tools are likely to be the best for the various types of 3D graphical information, including dynamic scientific data, 3D objects, and virtual environments.

The computer graphics community (and especially SIGGRAPH) can provide a major service to mankind by promoting the use of graphical tools that improve the effectiveness of the Information Superhighway. A significant step in this process is an open comparison, evaluation, and discussion of the graphical tools being proposed. The panel provides this step by having demonstrations and open discussions of the proposed tools.

The issue is much larger than just the issue of data formats for Internet. The tools should provide for efficient access of the information, effective analysis, and effective collaboration with others over the Internet.

The organizer has selected tools for demonstration that he believes have the greatest potential at this time. The selected tools for 3D objects and virtual environments are QuickTime VR and QuickDraw 3D by Apple Computer [1, 2], WebSpace by Silicon Graphics [3], and a public domain 3D browser from the Geometry Center of the University of Minnesota [4]. QuickTime VR is based on images. QuickDraw 3D is a cross platform 3D graphics API. WebSpace and the Geometry Center's public domain browser are based on the Virtual Reality Modeling Language (VRML) described in [5]. The selected tool for 3D scientific data is the FASTexpedition described in [6]. (It is not expected that one tool will be the best for all applications.)

Gavin Bell

The VRML 1.0 draft specification defines a general, powerful, extensible language for describing objects and scenes. It is a subset of Open Inventor's ASCII file format, plus two extensions for reading objects from across the internet. Open Inventor's file format was chosen as the basis for VRML because it has repeatedly proven itself to be useful for exchanging information between applications, it is stable and very well supported, and there are already a large and growing number of tools written which work with the Inventor file format.

The challenge when designing VRML was to make it as simple as possible, so that it was fairly easy to implement, but to make it general enough so that it could be THE standard for exchanging resolution-independent, three-dimensional graphical information. At the same time, it had to be bandwidth-efficient and scalable to allow potentially infinite virtual worlds. I believe those goals have been met.

Extensibility is almost as crucial as simplicity and generality when defining a widely useful product. VRML retains the extensibility features of the Open Inventor file format. It defines the syntax for new types of objects, allowing tools that don't understand the new objects to read and write them properly. VRML will never be finished; however, it provides the solid foundation of a common language upon which a rich set of tools will be built.

The ultimate goal of networked, distributed 3D graphics is a full-fledged cyberspace; a collaborative, distributed, interactive virtual meeting place, where people can get together to become educated, create something new, entertain each other, or conduct business. The VRML 1.0 draft specification is really only a small (but very important) step towards that goal. VRML defines static, non-shared, distributed 3D objects and scenes. However, I'm confident that VRML will be extended to describe animated objects, interactive objects, simulations, and objects with complex behaviors. And I'm confident that technologies for collaborative information environments will be developed, and that they will be combined with VRML to produce the kind of infinitely scalable shared cyberspaces that science fiction authors have been writing about.

Tamara Munzner

Three dimensional graphics can be integrated into the World Wide Web at many levels. Currently, most authors of hypertext documents can rely on the availability of external viewers for 2D images. The next step is to encourage authors to routinely include 3D scenes in documents, which depends on widespread availability of 3D browsers on all common platforms and agreement on a 3D object format. VRML provides a standard for 3D world interchange, and additionally the capability of embedding hyperlinks in the 3D objects.

For some applications, the most appropriate use of the Internet is simply to download 3D data and interact with that data locally. For other situations, further interaction through the Internet is reasonable, and the netlag incurred is an acceptable price to pay for distributed capabilities. I will demonstrate applications that explore the potential of incorporating hyperlinks into interactive 3D graphics, including visualizing the connectivity of Web itself.

Although ideally every user would like to run interactive 3D browsers locally, the reality of hardware and software often falls short of the dream. Even though machine speed is rapidly increasing, there is a large base of users with older slow machines, particularly in the schools. Organizations are moreover often unwilling or unable to devote resources to porting

software to every possible platform. I will demonstrate "quasi-interactive" 3D applications that run directly through conventional and widely available Web browsers without any additional local software installation. The threshold of interactivity is much lower than conventional interactive 3D graphics viewers: an update can take minutes rather than a fraction of a second, since a new image created in response to local user interaction is computed on the fly at the server end. While these applications are bandwidth-intensive since pixels are being sent through Internet, they are a step up from precomputed movies since the user controls what is seen. The toolkit for creating such applications allows application writers to sidestep issues of porting, distribution, and hardware speed.

Fabio Pettinati

The Web and 3D graphics have always been on a collision course; it was just a matter of time for it to happen. The recent VRML proposal is just the beginning of an encompassing collaborative environment, where people can learn new concepts, travel to distant places, explore new business opportunities, or just entertain themselves. The concept of using 3D graphics technology to help create the illusion of a virtual space has been received with enthusiasm by researchers, the press, and end users.

The concept of a well-defined and standardized virtual reality modeling language (in its current VRML instantiation, or any other future form) is critical to establishing the foundation for a successful cyberspace. More critical, perhaps, is the need to accommodate additional data types that can convey the illusion of three-dimensional spaces. A very good example is Apple's QuickTime VR technology. QuickTime VR immerses users in a three-dimensional environment represented by panoramas. The illusion of movement can be further enhanced by linking panoramas together, and using hot spots for navigation. One of the advantages of this technology is the ability to convey a rich visual experience with very low bandwidth requirements: exactly one of the limitations in today's Web. For those users who would prefer the freedom to explore virtual worlds beyond what is possible with panoramas, traditional 3D rendering environments are the natural choice. On Macintosh and other personal computer environments, always popular among Web users, Apple's new 3D graphics API, QuickDraw 3D, can render VRML models with great efficiency and speed.

The ability to move virtual space scenes to a client computer, and to render them seems trivial when compared to the issues of offering users a rewarding experience. This makes the Web the ideal laboratory environment. By virtue of its large-scale distributed environment, and the speed with which it disseminates information, the Web lets researchers explore new rendering algorithms, and fine tune new interaction paradigms, in ways never previously imagined. At the same time, the Web places a tremendous responsibility in the hands of these researchers: the Web's user base is constantly evolving and becoming predominantly composed of non-computer literate users who crave for interesting content, and the opportunity to explore exciting sites. These same users will flatly reject Web sites they perceive as unattractive, regardless of their technical merits.

Offering users rich content and enticing interaction metaphors are two important areas that often are not seen as research topics, but that are critical to the Web's future.

Val Watson

Scientists, teachers, and students can now obtain information about dynamic scientific phenomena from the Internet — however, the format is usually a pixel file to be shown with a movie player. Movies show only one unchangeable sequence of views of the phenomena, and no "what if" analysis can be performed.

For phenomena that can be represented by vector and scalar fields, a much more effective tool than the movie player should be used. The demonstration of the FASTexpeditions will show that, with "clicks of a mouse" on a Mosaic page, one can obtain all of the following: (1)the vector and scalar data representing the phenomena; (2) a rich variety of guided expeditions through the data; (3) the ability to branch off from the guided expeditions for independent "what if" analyses with a sophisticated analysis tool; (4) the ability to explore the data in a truly 3D space; (5) the ability to interactively collaborate on the exploration of the data with fellow scientists, teachers, or students at remote sites.

I would like to see the computer graphics community work with agencies such as the National Science Foundation to: (1) select some of the best graphical tools for use with Internet; (2) promote the use of these tools by Internet information suppliers and users; and (3) bring these tools into the schools as quickly as possible

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