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Introduction

The technology of *multimedia* blends publishing, entertainment, and computers into a medium for information exchange that expands the potential of all three areas. The Microsoft® Windows™ operating system version 3.1 has brought this technology to the desktop personal computer. Microsoft Multimedia Viewer version 2.0 allows you to bring that technology alive in titles—online "books"—that may include text, sound, animation, graphics, and video. This guide is a simple example of a Viewer title.

This is a guide for developers who want to create multimedia applications (or *titles*) for Windows. Building a multimedia title involves many people—programmers, writers, artists, musicians, and sound engineers—and therefore requires someone to coordinate the activities of these different professionals into a coherent project team. This person is sometimes known as the *multimedia producer*.

This guide was written to help multimedia producers and their team members to understand the technologies and issues involved in developing a multimedia title. It contains descriptions of authoring processes along with comments and suggestions about using different hardware and software. Multimedia producers should read the entire guide for an overview of the technology involved in building a multimedia title. Team members should read the specific modules relevant to their area of responsibility (such as text, images, or audio).

This guide assumes some experience with personal computers running under Microsoft Windows and MS-DOS®. For information on Viewer authoring procedures, see the *Microsoft Multimedia Viewer Authoring Guide,* another part of the Microsoft Multimedia Viewer Publishing Toolkit.

This module introduces the software and hardware involved with building and using a multimedia title.

Introduction

Windows

Windows provides the underlying software support for multimedia. It does this by providing the following features in the standard platform of Windows 3.1:

- Audio support for digital audio and MIDI devices. Device drivers are included that can play disc-resident digital audio and MIDI files in the background while an application is running. This includes support for compact disc digital audio (CD-DA).
- Standard MIDI instrument patch management services allowing MIDI files authored on different MIDI hardware to play back on the multimedia PC without modification.
- Media control support through the Media Control Interface (MCI) that can accommodate any media-related device including digital audio devices, scanners, video overlay cards, and videotape players.
- Several new VGA video display drivers, including a high-resolution display driver for 8-bit VGA+ (256-color) display adapters with improved performance and new features, a high-resolution display driver to display 256-color bitmaps in 16 shades of gray on a standard 16-color VGA display, and a display driver to show 256-color bitmaps at 320-by-200 resolution.
- A new *extensible* Control Panel that allows application developers to add custom Control Panel applications (also known as *applets*). Also included are new Control Panel applets that allow users to change display drivers, set up a screen saver, select sounds to associate with system events, and map MIDI instruments so that externally produced MIDI files will play without modification.
- Support for analog joysticks.

These multimedia features in Windows 3.1 provide multimedia developers with a standard system software platform on which to build and deliver their applications. You also need a practical way to combine different types of information into an inexpensive format for easy distribution and access. That's the role of Multimedia Viewer.

Introduction

Multimedia Viewer

Viewer is a Windows-based authoring and viewing environment used to create titles that combine the following elements:

- Text, with hypertext elements such as jumps, browse sequences and popups
- Pictures, including bitmaps and metafiles
- Multimedia sequences such as speech, music, animation and video

For more information on Multimedia Viewer, see the *Microsoft Multimedia Viewer Authoring Guide* and the *Microsoft Multimedia Viewer Technical Reference,* both included in the Viewer Publishing Toolkit.

Viewing multimedia files requires a hardware platform capable of processing and presenting video and audio information. The multimedia personal computer (MPC) is the component that meets this need.

Introduction

The Multimedia PC

Multimedia PCs are a specific class of PCs that meet or exceed the Multimedia PC Specification 1.0 (November, 1990). The MPC trademark indicates that the hardware complies with this specification. The minimum hardware requirements in this specification are summarized below. Your system may differ as various machines use more advanced hardware to provide higher quality sound and performance characteristics.

CPU

80386SX or compatible microprocessor

RAM

2 megabytes (MB) of RAM

Magnetic Storage

3.5-inch floppy disk drive, 1.44 MB capacity
30 MB hard drive

Optical Storage

CD-ROM with compact-disc-digital-audio (CD-DA) outputs, a data-transfer rate of 150 kilobytes (K) per second, and an average seek time of 1 second or less

Audio

8-bit DAC (digital-analog converter), linear PCM sampling, 22.05 and 11.025 kHz rate, DMA/FIFO with interrupt

8-bit ADC (analog-digital converter), linear PCM sampling, 11.025 kHz rate, microphone input

Music synthesizer capable of six simultaneous melody notes plus two simultaneous percussive notes

On-board analog audio mixing capabilities

Video

VGA-compatible display adapter, and a color VGA-compatible monitor

Input

101-key keyboard
Two-button mouse

I/O

MIDI in/out/thru port

Serial port
Parallel port
Joystick port

A variety of hardware manufacturers provide fully integrated multimedia PCs with these components already built in, or supply upgrade kits to transform a current 80386SX or higher computer into a multimedia PC. The MPC trademark is one easy way to recognize whether computer hardware or software is compatible with Windows. An MPC can present multimedia titles; to author them may require higher capabilities.

Introduction

Basic Authoring Software and Hardware

You'll need to set up a development environment for creating multimedia titles. This involves acquiring the right software and hardware:

- The Microsoft Multimedia Viewer Publishing Toolkit, operating under Microsoft Windows version 3.1, is your essential software package. It includes the data-preparation and authoring tools needed to build a multimedia title under Viewer. (You'll need Microsoft Word for Windows to use Viewer as an authoring tool.)
- To exploit the capabilities of the Windows multimedia APIs at a higher technical level, the Microsoft Windows Software Development Kit (SDK) version 3.1 is the critical software package. You should also consider acquiring additional data-preparation and development tools as necessary.
- The multimedia PC you use to build your application should be powerful, based on an 80386 microprocessor with at least 6 MB of RAM and at least an 30-MB hard drive. While you will use the same hardware components for sound, MIDI, and image display as those present in the standard multimedia PC, all other components should be as high-performance as you can afford.

Additional hardware and software may be required, depending on the types of data you use in your application. For more information, see the modules of this guide discussing particular data types.

How This Guide is Organized

The other modules of this guide cover the following subjects:

- "Creating a Multimedia Title" describes the authoring process for a multimedia application.
- "Managing Data" discusses storing and managing the data used in an application.
- "Images" describes digital images and their preparation.
- "Animation and Video" briefly discusses the Viewer compatibility and features of animation and video.
- "Audio" explains digital audio technology.
- "MIDI" presents an overview of the Musical Instrument Digital Interface (MIDI) technology.
- "Text" discusses the conversion and preparation of text.
- "CD-ROM" highlights CD-ROM technology and production issues.

You can always see a list of these modules by clicking the Contents button at the top of your screen. Click on any button in the table of contents to expand that item to a list of the topics in that module. Click anywhere on the list to display that topic. To move forward or back among topics in a browse sequence, use the arrow buttons at the top of the screen.

The name of the current module appears across the top of every topic screen, along with a row of buttons representing each module of this guide. Click on any button to jump to a list of that module's topics.

To search for the appearances of a word or phrase anywhere in this guide, click the Search button at the top of the screen.

Copyright and Trademarks

Creating a Multimedia Title

Introduction

An electronic document differs substantially from a printed one only if the multimedia production team carefully designs the electronic title to exploit the hypertext and multimedia capabilities available to it.

Simply transferring the internal design of a book to an online medium fails to take advantage of the potential power a computer can offer.

Publishing professionals know what they want from a book they are producing, and instinctively know how to design the project to achieve those results. To achieve the same results in the unfamiliar medium of electronic publishing may require a more deliberate development process.

This chapter briefly discusses some of the issues associated with developing a multimedia title. The process of creating a multimedia application usually begins when an idea germinates and one person or a team of people comes up with a marketing rationale and an action plan for producing the product. There are three general rules that apply in every case:

1. Know exactly what you want the product to be
2. Establish what you want your title to contain
3. Prepare the data you'll be using

The purpose of this chapter is to discuss the issues associated with these rules in enough detail so you can develop a specification for your title. This specification should be a full, detailed description of the images, sounds, structure, and user-interface features of your product.

Creating a Multimedia Title

Types of Multimedia Titles

The best multimedia titles are interactive. Unlike the reader of a book, compelled to turn pages in a fixed sequence from beginning to end, the viewer of a multimedia title can shift the information focus at a whim. If the scene presented isn't desirable, the user can choose another with a click of a button. The focus remains the information provided; graphics, audio, animation, and video help make that information more accessible. When applied creatively, these multimedia capabilities can greatly enhance software applications. The acronym PIECE stands for the five basic areas where multimedia might be successfully applied:

- Productivity Titles
- Informational Titles
- Entertainment Titles
- Creativity Titles
- Educational Titles

You can build applications specific to each area, or you can create multimedia presentations with aspects of each. The only limit is your creative application of the technology. The following topics briefly describe each area; the examples are meant to start you thinking.

Creating a Multimedia Title

Productivity Titles

One major reason that computers swept through the business world was the many applications designed to improve worker productivity. Standard productivity applications include word processors, presentation packages, spreadsheets, and databases. If you are a multimedia producer for a company that offers these kinds of products, you should consider how Windows and the multimedia PC could enhance the productivity of software users.

For example, a spreadsheet could provide support for such enhancements as voice annotation of specific cells, saving memo-writing time. Presentations might be so enhanced by video, audio, and animation that they would no longer require a presenter.

Another area that could be enhanced by multimedia is documentation. Tutorials or service manuals could include graphics, voice, and animated information as well as the standard text and branching mechanisms. The degree of detail within a such a title could be greatly expanded with the increased amount of storage available on the CD-ROM. For instance, instead of just a general illustration of a mechanism, you might also include a complete set of blueprints of each individual part.

Creating a Multimedia Title

Informational Titles

Most information products—such as encyclopedias, dictionaries, atlases, and medical references—still come packaged as paper. The massive storage capacity of CD-ROM, coupled with the advanced graphic and audio capabilities of Windows, offers opportunities for innovative information products.

For example, Microsoft now offers Bookshelf for Windows, a complete set of reference resources including *The American Heritage Dictionary, Bartlett's Familiar Quotations,* and the *Concise Columbia Encyclopedia.* Bookshelf for Windows includes the text for these and other popular reference works, and it also provides animations, audio, and high-quality graphics: the encyclopedia shows the solar system in motion, and the dictionary pronounces its words.

Creating a Multimedia Title

Entertainment Titles

A major reason for the success of personal computers is their potential for fun. Computer games have often stretched the limits of computer hardware and improved user interfaces. Now, with the capabilities available through the multimedia PC, computer entertainment can take gamers down more exciting and realistic paths than ever before.

The first computer games relied mainly on interactive text and the player's imagination. The second stage offered colorful, interactive graphics. Multimedia games can incorporate live-action photos, animation sequences, and sudden bursts of movement and sound. A trip to the bottom of the sea could show schools of fish darting in multiple directions as the hull creaks from increasing water pressure. In maneuvering the ship, the gamer would contend with a vast reservoir of statistics against which every action is measured and responded to.

Entertainment comes in many forms beside games. Multimedia creates interesting opportunities for literature. Along with plot and character, authors can now consider appropriate images, animation, video and audio. The reader might hear Cinderella's waltz or see Jack's beanstalk grow. A novel set during the U.S. Civil War might include historical maps, music from the period, Matthew Brady's photographs, and the text of the Gettysburg Address.

Creating a Multimedia Title

Creativity Titles

One of the ways computers make people more creative is to provide tools that support the creative process. Word processors make writing easier by reducing the drudgery of typing and retyping. Paint and drawing programs enable nonartists to produce elegant illustrations. Better tools let you focus on the act of creation itself.

The multimedia PC supports many different creative endeavors. The MIDI interface allows a single person to not only compose a score, but also orchestrate and "perform" it. The CD-ROM can store extensive amounts of information with which an artist can work. Huge libraries of generic multimedia objects will emerge from which multimedia producers can choose during development:

- Audio clips (hit songs, classical, jazz, sound effects)
- Video clips (film and television excerpts, scientific and legal records)
- Clip art (icons, cartoons, figures, and graphs)
- Photos (wire photos, nature scenes, famous people)
- Boilerplate text (quotes, speeches, definitions)
- Typefaces (for word processing and graphic design)

Multimedia PCs can be used to create and deliver desktop presentations for business, education, or even for home viewing. Incorporating the elements of multimedia enhances existing applications and creates entire new genres of tools for creative development.

Creating a Multimedia Title

Educational Titles

Multimedia adds a fresh splash of color to the palette of educational alternatives. The strengths of computer-aided instruction—interactivity, personalized instruction, and multiple layers of complexity—can be further enriched through audio, video, animation, and music. Opportunities for educational multimedia products exist in several categories:

- *Elementary and Secondary Education.* At lower grade levels, the courseware might resemble interactive games with flashy graphics, animation, and sound effects. At higher grade levels, these properties would still exist, but the information content would increase.
- *Adult Education.* For example, many adults want to learn a foreign language. A multimedia application could provide the student the phrase in both the native and foreign tongues, phonetic spelling, and an audio clip of correct pronunciation. Hypertext links could pop up windows with synonyms or related verb tenses.
- *Career-Oriented Self-Paced Instruction.* For example, you could produce a tutorial on giving oral presentations. It could explain the principles of public speaking, and also provide recordings and footage of great speeches. Other windows might display the text of the speech, with annotation to highlight rhetorical techniques. An animated slide show could explain the pros and cons of different types of presentation graphics.

The quantity of information available from a CD-ROM fulfills the concept of information browsing. A student could explore the learning environment by strolling from one topic to the next. A supportive narrative voice might come along as the student examined an archive of fiction, photographs, and song.

Creating a Multimedia Title

Defining the Title

The first step in developing a multimedia title or application is to define the reason for building the title and describe its potential. The inspiration for a title can happen from a single idea, such as, "Wouldn't an online tour through the USA be neat?"

Defining a title involves the following processes:

- Identifying the Audience
- Specifying the Content
- Designing the Title's Structure
- Establishing Design Standards

Eventually, the product definition should materialize into a high-level product description and business plan. Other topics of this module offer some basic tips on how to design a multimedia title and describe some of the processes you must go through during development.

Identifying the Audience

Understanding the audience is critical to the success of the title, as this definition drives nearly all aspects of the title's design. When you define the audience for your application you should ask yourself such questions as:

- How much do they know about computers?
- How much do they know about the subject of the title?
- How will they use the information presented?
- How much work are users willing to do to access this information?
- How often will they need this information?
- When they need information, do they need it immediately, or will they feel they can browse through the material at leisure?
- Will they be viewing tiles in an environment where sounds and music would be an inappropriate distraction to others?

Having identified the potential audience, you can better specify the content of the title.

Specifying the Content

Consider the following questions in the light of what you know about your audience:

- What information should the title present?
- Should the title present only one level of detail, or be layered for different levels of interest?
- To what reading and maturity level should the material be written and selected?
- Which aspects are best suited to text and which to multimedia presentation?
- What data resources are available? What must be created?

Asking these and other questions may help to focus the discussions associated with the design process. When doing this exercise, try to identify everything possible about the subject, the data resources available, the software tools available for producing it, and the team necessary to produce it.

Now that you know your title's purpose and content, you can define its structure.

Designing the Title's Structure

Once you decide on the purpose and content of the title, you must determine how to structure this information for the most effective presentation. Remember that a multimedia title differs from a printed text. You aren't limited to a purely sequential, front-to-back structure—the title should provide an interactive experience to the user. The choices a user makes while viewing a title should directly affect what they see. Incorporate the concept of interactivity into the structure of your title.

Once you have discussed and made decisions concerning these issues, you can start working out scripts, storyboards, sample screens, and prototypes. This is also where the real designing occurs. To prototype your application, you can choose the traditional scripting and design methods, such as copyboard drawings and typed scripts. Or you may wish to go directly to Viewer to produce a prototype—even if you plan to use Windows programming techniques to build the final application.

The Contents Topic

One classic navigational landmark within text-oriented multimedia applications is known as the *contents topic*. The contents topic serves as the entry point into the title and as a safe haven for users whenever they become lost in information.

The contents topic sets the tone for all other topics and therefore should establish a consistent and meaningful design that underlies the entire title. It acts as the center of navigation for the title just as a table of contents helps the reader identify the parts of a book.

In many cases, the contents topic lists all the categories covered in the title and provides a cross-reference jump to each category.

Creating a Hierarchy and Browse Sequences

Another aspect when structuring text-oriented information to consider is the hierarchy of related topics and how this affects the sequence in which the title presents information.

The information in a multimedia title may take the structural form of a pyramid. The apex is the contents topic. Beneath it are the several basic topics with the core material. Each of these, in turn, leads to additional levels through cross-topic jumps to related topic screens. This establishes a hierarchy of information.

Information at the same level of the pyramid may represent a continuation of prior screens, and not an additional level of thought. In these situations a *browse sequence* would probably prove beneficial. A linear browse sequence tells the viewer that the information contained in a series of topic screens should be read sequentially from start to finish for maximum understanding. This topic is part of a sequence on Creating a Multimedia Title.

In practice, hierarchy alone cannot be allowed to dictate the creation of cross-topic jumps and browse sequences. Common sense and the convenience of the user must be your guides.

Identifying Cross-Topic Jumps

Multimedia Viewer can connect related topics through cross-topic jumps. You can choose images or words as jump areas—hot spots—and specify the topics to which those jumps lead. You can place

jumps to multiple topics within a single topic.

The effective use of this power requires a certain amount of discretion. A large number of jumps lets the viewer browse through information in a totally unrestricted manner. The benefit of this is that the user can access a vast amount of information easily. Cross-topic jumps, however, have some drawbacks:

- Large numbers of jumps can make navigation overwhelmingly complex.
- It takes time to test large numbers of jumps to ensure they work correctly.

Multimedia Viewer provides built-in navigational aids to help a user reestablish position within the title. Nevertheless, as designer, you should make sure that all jumps included in a title serve a useful purpose.

Establishing Design Standards

Printed books have a certain look, an underlying graphic design that helps to promote consistency and clarity. It's important to make sure your multimedia title adheres to a consistent internal design—topic screens look alike, typefaces are consistent, and multimedia elements such as audio, graphics, and animation integrate cleanly into the overall feel of the title.

Given the large and varied number of text, audio, and graphic resources that could come together in your title, you should take the time to identify some basic design standards at the beginning of the development process.

You should decide on an overall visual concept or metaphor for your title. For example, in a title about touring the USA, the basic metaphor might be a map of the United States. Other visuals in the title can build on that basic metaphor as they provide information and guidance.

The Design of Topics

As you divide the information in your title into separate topics or screens, you should strive to ensure they maintain a consistent style in terms of written voice, content, and breadth of information.

For example, decide whether you intend to require the user to scroll through the information in a topic, or whether instead you'll limit topics to only the amount of information that can appear in a standard window. This decision affects the design of your title—shorter topics can require a greater number of browse sequences or cross-topic jumps (possibly not a good idea with CD-ROM as this increases the number of times the software has to access the optical disk).

The Use of Fonts

The fonts you choose for your text play an important part in ensuring the readability and aesthetic qualities of a title. Some typefaces are easier to read online than others (for example, some research indicates sans serif fonts work better online than serif fonts). Windows provides flexibility in your choice of fonts, font size, and font colors. Inconsistency and poor design in the use of these typefaces can detract from the information content of your title.

The Use of Audio

Audio samples—voice, music, or sound effects—can substantially enhance a multimedia title. You must make sure, however, that any audio used is easy to understand, and of consistent loudness and quality with other sound samples used.

Various factors affect audio samples: the number of bits used to store the sample (typically 8 bits or 16 bits), the quality of the equipment used to obtain the sample, and the sampling rate at which the original sound was digitized (11.025 kHz, 22.05 kHz, or 44.1 kHz). The higher the sampling rate, the better the quality. The better the quality, the more disk space required for storage.

If you decide to include audio with your title, make sure you take the time to understand the associated issues and establish some guidelines. For more information on audio, see the Audio module of this guide.

The Use of Images, Animation, and Video

Images, animation, and video add tremendous value to any title. Good visuals communicate efficiently: They convey the desired information and feeling with a minimum of distraction and misunderstanding. If you choose to use these visual elements with your title, make sure to include their usage in your design standards.

Establish guidelines for all aspects of how your title will display images, animation, and video: placement and style of frames, use and number of colors, scale and style of illustration, and many other factors.

For more information on static images, see the Images module of this guide. For information on animations and video, see the Animation and Video module.

Establishing a quality design standard before development takes some time, but adherence to professionally developed standards not only makes your title look better, it helps make it easier to use—and easier to market as well.

Preparing the Data Used in a Title

One of the more involved and time-consuming aspects of multimedia product development is gathering all of the text, sound, and image data you plan to use in your product. Animations, video, images, text, and sound must be digitized from various sources, edited, and eventually converted to the final storage and presentation formats required by Multimedia Viewer and Windows.

The cost for data-preparation tools, systems, and labor is significant. For example, to digitize, convert, touch up, and crop a single image can take from several minutes to an hour. Scripting, recording, mixing, and editing a few minutes of sound can be just as demanding. Consequently, you'll want to always be looking for tools and methods that allow you to automate and improve the production process. Your efficiency in this process directly affects the overall cost of development.

One key point to always consider: Plan for the future. You should always prepare data for a title with the objective of recycling it within other titles. Spreading the data-preparation costs across multiple titles is simply a smart way to maximize your return on investment. Look for ways to use the same information in different products—for instance, a multimedia encyclopedia and a series of educational titles.

Other modules of this guide describe some of the issues associated with preparing five basic types of multimedia data resources: images, animation and video, audio, MIDI, and text. Each module presents an overview of the processes involved or directs you to specialized information resources.

Caution

Never digitize music from professional recordings, or images from magazines, books, movies, or other recording media, if you plan to use these resources in your final product—most are protected by copyright. If you find something that you want, get permission to use it or you will be violating copyright law. The "Multimedia Producer's Legal Survival Guide," by Stephen Ian McIntosh, is a good source of information on this subject.

Building the Title

When you know what content and features you want your product to have, how you want it to look, and how you want the user to navigate through it, you're ready to decide on the tools and methods you'll use to create it. Multimedia software products can be created in one of two ways as discussed in the following topics:

- Using a Programming Language
- Using the Multimedia Viewer Authoring Tool

In almost all cases, the authoring method you use imposes certain restrictions on the scope of your design. To design the product, you'll need to know the limitations of the tools you have available. However, to create a truly innovative product, you won't want to box yourself in by these limitations.

Using a Programming Language

The Microsoft Windows Software Development Kit version 3.1 includes a complete set of functions for building Windows-based multimedia applications. Developing a multimedia title through this approach offers the most flexibility in the design of a title; it also requires the highest level of technical skill.

Should you decide to go this route, obtain the services of experienced Windows programmers. They require a working knowledge of both the C programming language and the Windows development environment.

The *Multimedia Programmer's Reference* and the *Multimedia Programmer's Guide* in the Windows SDK describe in detail the use and content of the application programming interface (API) for multimedia applications.

Using the Multimedia Viewer Authoring Tool

Tool-built titles are created using a specialized tool, or set of authoring tools, that provide the basic building blocks and framework for creating an application. These tools can be used by nonprogrammers, though some programming knowledge generally helps.

Authoring tools are typically best suited for content-rich applications—those loaded with text, images, and sound. Because they are specialized for data delivery, they are often not as flexible or efficient as programming languages. Their benefits lie in their ease of use, fast development cycles, predictable characteristics, and reliability.

This package includes the Multimedia Viewer authoring tool. Viewer was designed primarily to develop mainly text-based titles; however, it does support images, animation, audio, and video. Viewer requires Microsoft Word for Windows to create the source files for the title. You then use these source files to build a title for display with the Viewer runtime engine.

The *Multimedia Viewer Authoring Guide,* a book in this Viewer Publishing Toolkit, describes the capabilities of Multimedia Viewer and explains how to use it to build multimedia titles.

Managing Data

Introduction

Introducing multimedia data resources creates additional challenges for publishers and application developers. A key issue in creating multimedia titles is managing the many data elements—text files, audio files, bitmaps, animations, and video sequences—used within a title.

One of the main reasons good data management is so important is the expense of those resources. Multimedia data resources are expensive in many ways:

- Copyright costs for text, images, audio, animation, and video
- Work-hour costs of preparing the resources—converting from analog sources, translating different file formats, and editing the resources
- Storage costs—audio, images, animations, and video require lots of disk space

Effectively managing the data used to build a title can help control the costs of multimedia application development. Data management is a key part of creating multimedia applications, but it isn't really a step in the process—it underlies the process. You'll want a data management system in place when you start collecting your first set of images and sounds.

This module introduces some of the concepts and issues you should consider when figuring how to manage the data used in your multimedia title.

Managing Data

The Data Management Environment

You'll need to establish a hardware/software environment to handle the storage, transfer, and management of the data used in creating a multimedia title. There is no one right way to set up this environment—many different hardware and software solutions are available and new solutions arrive on the market almost daily. The following topics discuss some of the issues involved in setting up such an environment and offers some guidelines you can use when building yours:

- Storing Data
- Transferring Data

Managing Data

Storing Data

Storage is a major consideration. Data resources such as images, audio, animation, and video consume astonishing amounts of disk space. As you set up a multimedia development system, ponder your data storage and transfer requirements. The resources that make a title compelling also require a lot of storage:

- 16-bit audio digitized at 22.05 kHz eats up storage at about 1.3 MB per minute.
- Full screen, 256-color images can easily require 200-300K each.

Because you can always convert downward in quality but not upward, you'll want to capture your original data at the highest level of quality, such as 16-bit audio and 24-bit images. Recognize, however, that higher quality data typically requires substantial storage.

When you set up your development system, you face many data storage options. There are conventional hard disks of various types and capacities, removable hard disks, tape drives, and optical media, including WORM (write once, read many) drives and erasable optical drives. Each type of storage device has advantages and disadvantages. To sort them out, categorize your storage needs as follows:

- *Working media*, used during working hours to process data.
- *Archival media*, used for the long-term storage of images, audio, etc., in the highest resolution possible (24-bit images, 44.1-kHz audio).
- *Backup media*, used for day-to-day backup of data.

Working Media: Hard Disks

Your computer's hard disk is your active working storage area. It has to have enough capacity to hold your development software and current data resources. It also has to be fast enough for efficient use.

Two main factors determine the performance of a hard drive: *average access time* and *transfer speed.*

- Average access time, measured in milliseconds (msec), is how long it takes the drive to find the data the computer has requested. A reasonable range for average access time is 10 to 28 milliseconds (msec). Larger hard disks are usually faster.
- Transfer rate is the speed at which the drive can move data in and out of the computer. This is really a critical factor when dealing with large files, animation, video, or audio. Transfer rate is typically measured in bytes per second. A fast hard disk will transfer data at about 2 MB/sec; a slow hard disk can be as low as 40K per second.

Hard disks are available in sizes from 20 MB to 1.2 gigabyte. (One gigabyte (GB) equals one billion bytes.) You will probably want to consider 150 MB as a minimum size. Although the development process can be distributed among several computers, at least one station should have a hard disk able to hold the assembled title and any associated software.

Archival Media: Optical Discs

The critical elements for archival media are storage space, long-term viability, and cost. Optical media, specifically WORM discs, are excellent choices for this purpose.

The basic distinction between types of optical drives is whether you can only read data from them (CD-ROM), write data one time and then read it as many times as you want (WORM), or write and read to them as you would to a hard disk (erasable or rewritable). Each format has strong points: CD-ROM is a great distribution medium, WORM is good for permanently archiving data, and erasable optical (which is often also removable) is ideal in a development system and for transferring data between computers.

Erasable optical drives usually have a slower access time than magnetic drives, typically ranging from 35 to 180 msec. The transfer rate, however, is quite often comparable. Removable cartridges for erasable optical drives extend in size up to about 600 MB.

Backup Media: Tape Drives

For daily backup you want a highly reusable media, one that offers adequate storage and retrieval capabilities, and also provides reasonable performance at low costs. Magnetic tape has long served this need.

There is probably more computer data stored on 9-track magnetic tape than on any other medium, and it has long been the standard medium for transferring information around the country—for example, to CD-ROM mastering plants. But it is certainly not a fast or convenient method of getting to your information. And 9-track tapes typically hold only 30 MB to 80 MB of data.

New developments in magnetic tape technology, however, allow it to remain viable as a storage, transfer, or backup medium. New formats have come out that are smaller, faster, and store more data. One excellent format for digital backup is DAT (digital audio tape). Various implementations of this format store from 1.2 to almost 3 GB of data and have an average access time of less than a minute, sometimes a lot less. These drives aren't inexpensive, but the price is dropping.

DAT is also an ideal format for recording high-quality audio. With its high storage capacity and excellent fidelity, it can hold almost 4 hours of audio digitized at a 44.1-kHz sample rate with 16 bits per sample.

There are a variety of tape drives filling the gap between 9-track tape and DAT. These range in capacity from about 20 MB to 120 MB and are relatively cheap and slow.

Connecting Storage Devices

Simply obtaining a single massive storage device isn't necessarily the right solution for you. In many cases, you'll want to have the files distributed throughout your site on different types of devices. The exact details of resource flow will have to be determined for each site.

For example, you might perform all image collection, registration, and editing functions on a local workgroup of personal computers. Other PC workgroups could be dedicated to audio enhancement and text preparation. The central fileserver would only come into use after the resources have been prepared for final incorporation into the application.

Connecting these different types of storage devices to the different computers used at your site can be a complicated process, if various hardware interfaces are in use. Choosing one interface for universal use is a good solution; the SCSI interface is probably the best interface choice, for a variety of reasons.

SCSI (pronounced "scuzzy") stands for Small Computer Systems Interface. The power of this interface lies in its versatility and expandability. A single SCSI interface card lets you attach up to

seven devices to a computer, such as hard disks, tape drives, CD-ROM drives, and scanners. And it will typically move information between them, at a higher rate, than any other interface.

Note, however, that all SCSI interfaces aren't 100% compatible. If you decide to base your development system on an SCSI interface, make sure you purchase your equipment from a dealer who either knows the subject or is willing to let you experiment and take back what doesn't integrate properly.

Managing Data

Transferring Data

Since it is likely that you'll be developing your multimedia titles using a distributed workgroup of different computers, you'll have to choose a method for transferring information between these computers. This used to be a considerable problem, given that most sites have a hodgepodge of different computers of various incompatible operating systems.

Fortunately, it is now relatively easy to pass information back and forth between computers with different operating systems and hardware architectures. There are three basic ways to move files between computers:

- Removable media
- File-transfer software across a serial port
- Local area network

All three methods can be used to transfer information between different personal computers. Each method has its pros and cons, but generally you will find that speed and efficiency are directly proportional to cost. The following sections discuss each method.

Removable Media

One time-honored traditional way to move information between computers was to transfer the data to a floppy disk and run down the hall to the other machine—often referred to as "sneaker net." When floppy disks only held 360K of data, this wasn't extremely efficient. But with the increasing availability of high-capacity removable media, this approach has become practical in many situations.

Removable media are available in capacities ranging from 360K floppies to 600-MB erasable optical disks. The most practical mid-range entry is the 44-MB removable hard disk, marketed under a variety of brand names. Although removable media are not as convenient as a local area network (LAN), they can be an economical alternative in a small operation, particularly if you install SCSI cards in your PCs and simply move the drive between machines.

But if you want to move big chunks of data between different types of computers, and don't want to use a LAN, you should combine your mass storage needs with your data transfer needs and get one of the high-capacity removable-media drives previously described.

Serial Port

Possibly the least expensive method of moving files between computers that sit fairly close together is to run a cable between their serial ports and use specialized communications software. This method will transfer files too large to fit on a floppy disk, and can be fast enough to satisfy small production needs. However, it is difficult to connect more than two computers this way.

Local Area Network

Networks are probably the most effective way to transfer files in a production environment. They are also expensive, potentially more complicated than the other methods, and require setup, training, and

maintenance. However, if you are serious about creating an efficient production environment, invest in a network.

Several network systems, such as Microsoft's LAN Manager, are available to connect PCs with other types of computers. They allow any machine to access the storage devices attached to any other machine to open or transfer files. Since you will probably use a distributed system of several machines to produce and manage your data, be sure you have a network up to the task.

Data resources should be placed near those who use them. For example, clip art images belong on a file server close to those individuals that work with images. Audio waveform files belong next to the audio experts. Recent developments in technology allow for the creation of distributed databases, where individual servers contain only that portion of the database necessary to control the type of data for which they are responsible.

The subject of deciding which network to purchase, assembling the network, and managing the flow and storage of information on the network could easily fill several massive books. Issues such as backup, security, and access times across the net must be considered and addressed during design. Look for experienced, professional help before making any decisions regarding the acquisition, design, and maintenance of a network.

Managing Data

Managing Your Library of Data Resources

One major advancement for software development during the 1980s was the notion of re-usable code. Development groups made every attempt to share tools, source code, and development libraries whenever possible to reduce the need to reinvent the wheel for each new product cycle. This principle applies equally well to reuse of the data resources found in multimedia titles.

Multimedia producers should begin developing libraries of data resources. Such libraries become extremely valuable for vendors who produce many different products and progress through multiple iterations of a product's life cycle. The ability to coordinate and share expensive resources among different product groups can increase overall efficiency and reduce costs.

The type of library you build and the method in which you implement it depends on the needs and workflow at your site. The following topics in this sequence discuss these steps in creating and managing such a library:

Managing Data

Defining a Data Management Methodology

Before you start working with the various data resources, you should devise and put into place your strategy for managing them. Without a strategy in place, you may find yourself quickly overwhelmed by the large volume of resources necessary to build a full-featured multimedia title.

There are many different ways to manage this data. You should consider incorporating either or both of the following approaches:

- Using a database management system (DBMS)
- Establishing a specific logical directory structure

Using a Database Management System

A DBMS enables you to control quantities of resources that could number in the tens of thousands for single titles, and far more in environments where multiple titles are being developed.

A DBMS records both the existence of resources and the relationships between different resources. The reason a DBMS is so useful is its ability to consolidate and report information. You can run reports showing the type, number, and status of the different resources.

As producer, you will have your own specific areas of interest in managing the project. For example, you may want to know the total cost of the copyrights used, the distribution of images vs. text vs. audio, or the total number of images scanned vs. the number of images actually used. This and other types of information can be recorded in the database and made available both during and after a development project.

When deciding which DBMS to acquire, make sure the one you select has the following capabilities:

- Able to handle multimedia resources
- Compatible with standard networks
- Supports the relational database model
- Provides a forms utility to support easy development of front-end screens
- Works under a standard environment (such as MS-DOS or Windows)
- Provides adequate backup and purge capabilities
- Includes an easy-to-use report generator
- Configurable to meet different requirements

A good DBMS should provide the configuration and reporting tools necessary to let you obtain and distribute the types of information most important to you.

Setting Up an Appropriate Directory Structure

Another useful tactic to consider when establishing your development environment is to create a directory structure that supports your data management system. For example, you may want to set up a structure that divides all the different source files and data resource files into separate directories. If you're using Multimedia Viewer, such a structure might look like this:

\VIEWER, containing all necessary directories and files to build and run a Viewer title.

\VIEWER\TITLE, containing the directories and files relevant to a specific title, such as the project file and the final title itself.

\VIEWER\TITLE\DIB, containing the 256-color image files for a title.

\VIEWER\TITLE\BMP, containing the 16-color image files for a title.

\VIEWER\TITLE\WAV, containing the audio files for a title.

VIEWER\TITLE\AVI, containing the Video for Windows video files for a title.

\VIEWER\TITLE\RTF, contains the source text files for a title.

Many other logical and equally useful structures could exist. (If you're using a network, make sure to decide how to share information between workstations.) The effectiveness of such a logical structure depends on how easily it allows you to find and access specific resources.

Managing Data

Collecting and Registering Resources

You can gather data resources from many sources. You can get images from clip art, scanned photographs, or original computer artwork. Audio can be created, copied, or taken from analog/digital recordings. And tremendous volumes of text exist in multiple formats. There's no shortage of available resources.

The problem is keeping track of what you've got and where it is. Using a DBMS to register resources as they're collected can be extremely helpful.

You should design your database to include a description of each resource, its source, its location, its size or length, its format, and any known copyright or other legal restrictions on its use.

Another area helped by the use of a DBMS is tracking data resources built from parts of several different resources. This situation will not be uncommon. Your database design should let you register the new resource into the database. For example, say you register an image showing all U.S. presidents. You then use an image-editing package to pull out all presidents elected during the twentieth century. You now have a new image to enter in the database. You may want your database to identify the relationship between the original image and its derivative image.

Managing Data

Identifying and Selecting Specific Resources

Associating a database record with each resource can help support the creative process. By pulling information together easily and powerfully, a designer can examine multiple potential creative avenues before coding and implementation.

For example, say you want to put together a title about whales. Instead of having to remember the filenames for everything relevant to whales, you can instead use a database query to identify and collect resource records that relate to whales, the ocean, and sailing. Such resources might include pictures of whales, audio clips of whale songs, and articles about whaling.

Editing Resources and Updating the Database

The Viewer Publishing Toolkit provides various editing tools to view and enhance different data resources. (For more information on these tools, see the *Microsoft Multimedia Viewer Data-Preparation Tools User's Guide.)* Each time you change a resource, you should record the time and type of changes made.

For example, PalEdit lets you create a merged palette for use with several images displayed simultaneously. You could use the database to identify which images share that common palette. Later on, when you incorporate the images into the title, the database record for each reminds you that the images share a common palette.

Another use for the database is when you have several resources of different types that belong together. For instance, you might want to link a picture of a sperm whale with the sound of waves crashing against a beach. Your database should let you identify which data resources belong together, greatly simplifying the final act of linking them in the title itself.

Purging or Archiving Resources

Finally, after you've finished your title, the time comes to decide what to do with the resource files used during development. You can archive the files for later use, then purge them entirely. It's important that you do both, to save valuable data and reclaim precious hard-disk space.

You'll probably want to archive both new resources and existing ones that were significantly enhanced for the project just completed. Again, accurate DBMS records will prove invaluable.

Images

Introduction

The word multimedia naturally implies graphics—photographs, drawings, animation, and video—that add variety and life to presentations on your PC. This module discusses several key items about preparing and using images in multimedia titles:

- Digital image technology
- Alternative ways to acquire images for multimedia titles
- Software and hardware components for image acquisition and preparation
- A brief description of the image capture and preparation process

The process of transforming an image into a form that can be displayed in a multimedia title requires both ingenuity and a working knowledge of the available tools. This module presents an overview of the technology and the issues involved.

Images

An Introduction to Digital Images Technology

Images on a PC differ from other familiar types of images—such as photographic prints and handmade drawings—chiefly in that they are *digital*, stored as bits of mathematical code that can be modified to resize, recolor, reshape, and combine them at will.

Many digital images were never anything else. Modern draw, paint, and design software allows the online creation of much art that might in the past have been the product of brush and pen, and some that would have been unimaginable. Other digital images derive from originals created as photographs, or in a traditional artistic medium.

Digital image technologies have a place in multimedia production with the Viewer Publishing Toolkit. And all the images these technologies produce will either be *bitmaps* or *vector graphics*. Which format you use depends on the needs of your application. You'll probably combine both types of images in any multimedia titles you create.

The next few topics in this sequence describe some characteristics of bitmaps and vector graphics:

- Vector Graphics
- Bitmaps
- Resolution
- Image Depth
- Bitmap File Size

Images

Vector Graphics

Vector graphics are stored as a set of instructions. These instructions describe the dimensions and shape of every line, circle, arc, or rectangle that makes up a drawing. When an image displays, software reads these instructions and converts them to shapes and colors to display on the screen.

The programs used to create vector graphics are often called *draw* programs, as they are limited to drawing lines, circles, and other geometric shapes. Vector graphics images are built from lines, arcs, and circles, so they can't duplicate the same painted or photographic effects as bitmapped images. Vector graphics are most commonly used for line drawings, newspaper-style clip art, and architectural drawings.

The main advantage to vector graphics images is that each piece of the image can be manipulated separately. You can move the individual objects around on the screen, and you can shrink, enlarge, rotate, or twist them without introducing the distortion that often occurs when doing the same things to bitmaps. Vector graphic objects also maintain their unique identities when overlaying other objects.

The main disadvantage of vector graphics is that as the images get more and more complicated, they take the computer longer to render. Software developers often create complex images as vector graphics, then convert them to bitmaps for use in an application.

Many draw programs for Windows 3.1 now store images in the metafile format. Windows and Viewer automatically know how to display graphics files stored as metafiles for Windows. To use vector graphics stored in other formats, you will either have to convert them to metafiles or provide your own software to display them.

Images

Bitmaps

Bitmapped images (or *bitmaps*) are composed of a set of bits in computer memory that define the color and intensity of each pixel in an image. Bitmaps are typically used to reproduce images that contain lots of detail, shading, and color. Photographs, film negatives, and other illustrations are commonly stored as bitmaps.

You can create bitmaps by using paint software, by scanning photographs or flat art using a color scanner, or by digitizing video frames using frame-grabbing equipment with a VCR, videodisc player, or video camera.

The software tools used to create bitmaps are often called *paint* programs, as they require you to build the image by painting individual pixels a specific color. The standard bitmap format used by Windows is the device independent bitmap format (DIB). Generally, you'll create the images in some other industry standard format (such as PCX) and then convert them to DIB for incorporation into your title.

Bitmapped images often display more quickly than complex vector graphic images. Bitmaps can load directly into memory for display, eliminating the time needed by a rendering engine to build a vector graphic image.

Bitmaps, however, require more disk space than vector graphics, because bitmaps have to specify information about each pixel displayed on the screen.

Bitmaps can also include more information than a PC display system can display quickly or accurately. You must recognize the factors associated with resolution, image depth, and file size, as discussed in following topics.

Images

Resolution

Several kinds of resolution can affect bitmap quality: screen resolution, image resolution, and pixel resolution. You should understand the differences between all three when working with bitmap images.

Screen resolution is the maximum image area of the computer screen, expressed in horizontal and vertical pixels, for a particular video mode. The standard video mode for the multimedia PC is 640 pixels by 480 pixels. You'll have to consider screen resolution when establishing a target image size for a scanned photograph.

Image resolution is the size of the digitized image expressed in horizontal and vertical pixels. The image resolution can differ substantially from the screen resolution. For example, say you display a 320-by-240-pixel image on a 640-by-480-pixel display. In this case, the image size is one-half the screen resolution, so the digitized image only fills one-quarter of the screen. When the image size and screen resolution are identical, the image fills the screen. When the image size is larger than the screen resolution, the screen can display only a portion of the image—requiring the display software to support scrolling to see other portions of the image.

Pixel resolution can become a factor when you move images between different graphic display modes or computer hardware. Pixel resolution refers to the ratio of a pixel's width to its height (also known as the pixel's *aspect ratio*). This can cause unexpected distortions in an image that's transferred between machines with different pixel resolutions. For example, if you capture an image on a device that uses rectangular pixels with an aspect ratio of 1: 2, and later display it on a device that uses square pixels with an aspect ratio of 1:1, the image will be distorted. Fortunately, pixel resolution inconsistencies don't occur frequently as most displays use square pixels with an aspect ratio of 1:1. Also, most capture devices let you adjust the pixel aspect ratio for your system.

Images

Image Depth

A second limit involves the maximum number of colors used in a bitmap. Each pixel on the screen can have one or more bits of color information attached to it. The number of bits associated with each pixel in a bitmap is known as the *image depth.* Using one color bit per pixel in a bitmap allows the pixel to be either on or off—producing a monochrome image. Using four color bits per pixel allows the bitmap to support 16 different colors, and using eight color bits per pixel allows the bitmap to support 256 colors.

Note

A bitmap that uses one color bit per pixel does not necessarily display images in just black or white; it may use any two hues or colors.

Simple drawings and cartoons can get by with just 16 colors. Natural images, however, normally require at least 256 colors. Some software packages can now create 24-bit bitmaps that can contain 16 million different colors.

As the tones in the image are sampled to create a bitmap, a color palette—a table of distinct color values—is also created. Each color in a palette is identified by components of the colors red, green, and blue (RGB). The digitizing software assigns an entry in this palette to each pixel in the bitmap. The number of colors possible in the palette depends on the image depth.

A multimedia PC equipped with a standard VGA display can support 16 colors in 640-by-480 resolution mode, or 256 colors in 320-by-200 resolution mode. A multimedia PC equipped with an enhanced VGA display can support 256 colors in 640-by-480 resolution mode.

This disparity of quality creates somewhat of a dilemma. If you want to develop your applications for the broadest market, use 16-color (4-bit) bitmaps. However, Windows 3.1 automatically maps each color to the closest fit when displaying 8-bit images on 4-bit displays. Two 4-bit display drivers included with the system software can yield good results with this 8-to-4-bit mapping:

- The 16-color grayscale driver works with a fixed palette; results are good but color is lost since the image appears in tones of grey, black, and white. You can suggest that customers with 4-bit systems use the grayscale display driver.
- The palettized VGA driver supports custom color palettes; results are good if the optimal palette is used. You can include a custom palette giving good results displaying 8-bit images on 4-bit displays.

A color enhancement called *dithering* can also improve the appearance of bitmaps, whether they're monochrome, 16-color, or 256-color. Dithering is a technique for representing an image using fewer colors than it originally had. Using a subset of the colors defined for a bitmap, dithering varies the grouping of pixels to best re-create the effect of the colors lost. A good dithering method can create the illusion of having additional colors in a bitmap. You can create dithered 4-bit versions of your 8-bit images with BitEdit.

If you want your applications to have the greatest allure, use 256-color (8-bit) bitmaps. To guarantee optimal appearance on all multimedia PCs, include both 4-bit and 8-bit images and have your application identify the display capabilities so it knows which to use. The Viewer Publishing Toolkit provides the BitEdit and PalEdit tools for use with bitmaps and their color palettes. Use BitEdit to

modify and enhance the bitmap image itself. Use PalEdit to display and modify a bitmap's associated color palette. For more information on BitEdit, PalEdit, and other tools included in this package, see the *Multimedia Viewer Data-Preparation Tools User's Guide.*

Images

Bitmap File Size

The limitation associated with bitmap file size is the transfer time needed to find and copy an image file from a CD to computer memory (RAM) and display it on the screen. Note that this often must happen simultaneously with other events (such as playing music or responding to keystrokes). You have to take image size into account during the design of your title.

Here's why. It takes a full-screen, 256-color image 2 seconds to transfer from the CD to the screen. A full-screen, 16-color bitmap requires at least 1 second of transfer time. You need to consider both the seek time and the transfer time for an image when you define the context in which the image will display. For example, to make the time less noticeable, you can preload images into memory while something else is happening (for example, while the user reads text).

The size of the bitmap file directly relates to the number of bits in the image. The following formula shows how to calculate the storage needed for a bitmap:

> Size in bytes = (Height x Width x ColorDepth) / 8

Where:

"Height" is the number of pixels displayed vertically.
"Width" is the number of pixels displayed horizontally.
"ColorDepth" is the number of bits of color information stored per pixel.

Consider a full-screen bitmap at 1 bit per pixel (black and white only), where the display has a horizontal resolution of 640 pixels and a vertical resolution of 480 pixels:

> Size = (640 pixels x 480 pixels x 1-bit) / 8 = 38,400 bytes

This number represents the storage required for uncompressed images. Scan an identical 8-bit color image, and the size substantially increases:

> Size = (640 pixels x 480 pixels x 8-bit) / 8 = 307,200 bytes

Obviously, the easiest way to make an image appear quickly is to reduce its size. You can do this by reducing the width/height of your images, or by using images with a lower image depth value. Data compression techniques, such as run-length encoding (RLE), can also be used to reduce the image size.

Acquiring Images

You have a lot of flexibility in how you acquire images for your multimedia titles. Alternatives range from purchasing images from an image bank or professional photographer to capturing images yourself. Costs, image quality, and licensing/copyright issues can affect your final decision. The following topics cover four common alternatives:

- Purchasing Images
- Creating Original Art
- Scanning
- Video Frame Grabbing

Purchasing Images

Digital image libraries are becoming quite popular. The quality, variety, and resolution of computer-generated and digitized or scanned images are going up as fast as the price is going down.

Creating Original Art

If you plan to become seriously involved in multimedia publishing, acquire the skills in-house for creating images from scratch using paint programs. Most artists, given an electronic stylus and graphics tablet, have little trouble learning paint programs.

When you use a paint program to create artwork, you have access to many electronic tools equivalent to those found in an artist's workshop, such as airbrushes and paintbrushes. Paint programs also support smearing, mixing colors, rotating shapes, editing pixels, and many other features that only a computer can provide. All paint programs also provide tools for drawing simple shapes, selecting a portion of a picture, and cropping or resizing pictures.

There are advantages to creating your art:

- You have total control over the palette used.
- You don't have to worry about royalties or copyright concerns.
- You get exactly what you want.

Original artwork is particularly useful for icons, buttons, small graphics, and animations. It is also the only effective way to get good 16-color images. Artists accustomed to working within the constraints of 16 colors can do very impressive work—just look at video games!

Scanning

Many bitmaps used by a multimedia title will come from photographs. A photograph uses continuous tones and shades—colors that blend smoothly from one to another. By using a scanner or special digitizing equipment, you can transform photographs into bitmap images.

Scanning is the most common way to rapidly create full-color electronic images from photographic prints, slides, or pieces of flat artwork. The main drawback of scanners is that the scanning process is time-consuming. Scanning a large image at high resolution can take up to a minute or more of processing time. This adds up when you have a few thousand images to digitize. If a speedy production cycle matters more than having the highest quality, consider buying a good video camera and a frame grabber.

Note

Think twice before digitizing images from magazines, books or television—most of them are copyrighted. If you find some images that you can't do without, get permission to use them or you will be violating copyright law. The best places to start are the public relations or marketing departments of the companies claiming copyright ownership. Plan ahead—it can take several months to obtain permission.

Video Frame Grabbing

You can use a video camera hooked to a digitizing board in your computer to capture images. The digitizing board, often called a *frame grabber,* converts the analog signal from the camera to a digital format that can be read and enhanced by software the same as a scanned image. (Microsoft Video for Windows includes a video capture tool, VidCap, that can be used to grab single frames as well as entire video sequences.)

The biggest difference between a scanner and a digitizer is that a scanner can only capture an image from a two-dimensional source, such as a photograph or slide, while a digitizer can capture any video image. A digitizing board usually captures two-dimensional images faster than a scanner, but it doesn't necessarily provide the best quality for the money. So, unless you're willing to get the best equipment, you might be better off buying a scanner to capture two-dimensional images.

Setting Up the Image Preparation Environment

Preparing images for your title places more demands on your system than displaying the images. You'll need to perform the following types of tasks:

- Touching up images to remove imperfections
- Adjusting brightness and contrast
- Cropping images for the application

The following topics describe issues to consider when setting up an image preparation environment. These topics describes particular categories of software and hardware, without recommending any specific products.

Image Processing Software

Digitizing software can help fine-tune the process of scanning or frame grabbing. After you've scanned or digitized an image, you may have to do additional processing to prepare it for use in your product. This is where image processing software and paint tools come in.

Digitizing software, image enhancement software, and paint software often share common features. Some products have all three capabilities built in, while others specialize in one capability or another.

Digitizing Software

At its simplest level, digitizing software controls the scanner or digitizer you are using to capture an image. It may allow you to set the image size, select the portion of the image to digitize, specify the resolution and number of colors, and select the format in which to save the image file. Most of the high-end digitizing software also includes image enhancement and painting features.

You can probably get by just fine using simple scanning software and the BitEdit and PalEdit tools provided in this package if you don't need to do extensive editing to enhance your images.

Image Enhancement Software

Image enhancement software is designed to convert images to different formats, spatial resolutions, and color resolutions; to modify saturation, hue, tint, contrast, and brightness; to sharpen or blur edges; to modify palette assignments; and to flip, rotate, crop, and resize. Think of the image enhancement software as a digital photo-retouching product. You normally use it to make global changes to an entire image, such as blurring the background, changing all blues to greens, and so on.

One function that you will probably use on every image you scan or digitize is color reduction. When you scan or digitize a natural image at high color resolution, you capture millions of colors. Most of these colors, however, are simply subtle shades of a relatively few colors.

If you want to display the image on a computer screen that supports only 16 or 256 colors, then you will have to merge or delete most of the captured colors. Scanning and image enhancement software provide a variety of ways to do this algorithmically and manually.

BitEdit and PalEdit in this package provide simple edit functions for images and image palettes. For descriptions of these tools, see the *Data-Preparation Tools User's Guide* in this package.

Paint Software

Paint software is used to actually edit the contents of an image. Paint software is sometimes used in the scanning process to add special effects to an image or to work on color gradations and hues at a pixel level.

Use paint software to make minor changes to images. You can cut, copy, and paste segments of the image, or use tools such as a paintbrush or airbrush to add elements to the image.

File Conversion Software

The images used in your multimedia title can come from a variety of sources and computer platforms. Although your title may be designed to import any graphic format, it will run most efficiently if it imports graphics in DIB format for Windows. The BitEdit and Convert utilities in this package let you convert from a number of the most common graphic formats to DIB and back.

The following table shows the different formats supported by BitEdit and Convert. If your images are stored in other formats, you may need to use a two-step approach, first converting them to one of these standard formats and then to the final format.

Format	Extension	Capability
Apple® Macintosh® PICT	.PIC	Read, Write
AutoCAD™ Plot File	.PLT	Read
Autocad Format 2-D	.DXF	Read
CompuServe® GIF	.GIF	Read
Computer Graphics Metafile	.CGM	Read
DrawPerfect®	.WPG	Read
Encapsulated PostScript	.EPS	Read
HP® Graphic Language	.HGL	Read
Lotus® 1-2-3® Graphics	.PIC	Read
Micrografx® Designer/Draw Plus™	.DRW	Read
Microsoft RIFF DIB	.RDI	Read, Write
Microsoft RLE DIB	.DIB	Read, Write
Microsoft RLE RIFF DIB	.RDI	Read, Write
DIB for Microsoft Windows	.DIB	Read, Write
Metafile for Microsoft Windows	.WMF	Read
PC Paintbrush®	.PCX	Read, Write
Tagged Image File Format (TIFF)	.TIF	Read
Truevision TGA	.TGA	Read, Write

Image Processing Hardware

Additional hardware for an image preparation system is needed to capture a digital version of an image. Scanners are more commonly used to capture images for a personal computer; the other alternative is a video camera with a digitizing board (frame grabber). The following topics in this sequence describe the hardware needed for both of these image-capturing techniques:

- PCs for Image Processing

- Scanners
- Video Digitizing Equipment

PCs for Image Processing

Many excellent image creation and enhancement solutions exist for MS-DOS and Windows. Make sure your processor, memory, disk storage, and display can meet their demands.

- CPU: Look for at least an 80386 or better processor. You should also consider configuring your PC with plenty of additional RAM.
- Hard disk: Image files are large and fill up a hard disk quickly. Provide your system with sufficient disk storage (at least 300-600 MB) to capture, edit, and convert the images used by your application.
- Display: You should have at least a 256-color VGA monitor and card (8-bit) to review and edit images effectively. You may want to invest in a 24-bit monitor and card to view and edit higher quality images.

Scanners

Anytime you want to turn a photographic print, slide, or flat artwork into a digital image, use a full-color scanner and scanning software. The scanner builds a digital representation of the photograph and creates a corresponding image file. Scanning software can typically store images in PICT (Apple Macintosh) or PCX (PC Paintbrush) formats. Scanners can produce a far higher image resolution than most cameras. The best scanners digitize at a resolution of at least 300 dots per inch (DPI) with various color depths (1 to 24 bits per pixel).

Scanners come in two basic varieties: flat-bed scanners and slide scanners. Flat-bed scanners are used to scan printed materials and photographic prints. Slide scanners are used to scan photographic slides. Use a flat-bed scanner if the bulk of your images are flat art or prints. If most of your images are slides, use a slide scanner for quality reproductions.

Many different types of scanner hardware and software are available. If possible, use a scanner that can capture at 24 bits per pixel and at least 300 dots per inch of resolution. You'll probably want to edit and archive your scanned images in the original 24-bit format, and then reduce the images to either 8-bit or 4-bit format for the actual title. This lets you work with the highest quality image until satisfied it's ready for conversion to the lower resolution.

Video Digitizing Equipment

Video digitizing equipment—used for frame grabbing—consists of several devices and is more costly than a scanner; however, this image-capturing method provides additional features such as directly capturing images of three-dimensional objects. The equipment used in video digitizing is described in this topic.

Cameras

The digitizing camera you select can make or break your final product. Cameras come in a range of prices, from the inexpensive consumer variety to the $40,000 broadcast variety.

When shopping around for a camera, look for these qualities:

- Resolution: While you can use almost any camera to digitize your images, look for cameras with high resolution—the higher the better. You want to end up with an image that comes as close to 640 by 480 lines of resolution as possible. The typical consumer-quality VHS camera produces only 240 lines of resolution, which is not adequate. SVHS cameras produce over 400 lines when properly calibrated.
- Output: High-end digitizer boards accept RGB input, which will generally provide the best image. Some boards also accept S-Video and composite video inputs. Of these two, S-Video is the best. Avoid a camera that has only a composite video output.
- LUX: The lower the LUX value, the less light a camera needs. You'll want a camera that has a low LUX value, but this doesn't mean you want to under-light your subjects. Low light means lower quality images.

Lenses

In addition to the lenses that come standard with the camera, you'll also want a macro lens for close-up work. A zoom lens is a good choice for general use.

Camera Stands

A good camera stand is expensive but worth the investment. Here are few things to look for in camera stands:

- Moving platens to center and orient the images
- Quartz halogen lamps to get good light at low wattage
- Backlighting source for slides
- Motorized column for moving camera up and down
- Glass plate

Digitizer Interface Boards

The most popular and broadly supported digitizer boards can capture images at a number of resolutions. Choose a board that allows a resolution of at least 24 bits per pixel for color information. There are several products on the market—shop around before you buy. Some of the less expensive boards give you a lot of power for the money, and may be quite adequate for your needs.

Monitors

You may want a video monitor to view the video image before it is digitized. Either black-and-white or color monitors are acceptable, but color monitors have the added benefit of letting you see the color settings before you grab the frame.

Capturing and Preparing Images

Although scanning and frame grabbing are both relatively straightforward processes, the quality of your final images and the amount of work required to produce them can vary drastically, depending on how well you plan the project. The next few topics in this sequence describe the following aspects of the image-preparation process:

- Choosing an Image
- Capturing with a Scanner
- Capturing with a Video Camera
- Enhancing Images

Choosing an Image

All pictures are not created equal; some are just better suited for digitizing than others. For example, an image with a large section of clear blue sky may look like a good candidate in its original form, but a picture with less sky showing may be a better choice. Here's why: The sky is actually composed of dozens of shades of blue. The conversion software that converts this 16-million-color image (24 bits) to 256 colors (8 bits) will probably reduce these dozens of blues to four or five shades. The result is a striped or blotchy sky.

A good image-enhancement program will let you blend this handful of colors so that the blotches are barely noticeable, but every extra step adds more time (cost) to the overall production process. Making a good choice will save touch-up time later in production. This is especially true when the title's runtime palette size is limited to 16 or 256 colors.

Another important characteristic of the original image is its physical size. If the original image is too small, you may have to enlarge and distort the image. If the original image is too large, there may be too much detail and you'll have to shrink it. The best size is between 3-by-5 inches and 8-by-10 inches.

Here are some other important factors to consider when choosing images:

Images to use have:

- Consistent lighting with balanced contrast
- A moderate number of bold, mixed colors
- Image components that look good blended
- Low level of detail
- A prominent center of interest with a simple background

Images to avoid have:

- Hundreds of wildly varying colors
- Deep, dark shadows
- High contrast such as bright whites next to solid blacks
- Large sections of many shades of the same color (such as sky)

The texture of the original will affect the final quality. Use high-quality prints whenever possible.

Capturing with a Scanner

The best way to describe the scanning process is to explain the steps involved in converting a photographic print to a DIB (device independent bitmap) for Windows. The DIB format is the standard format for all bitmaps under Windows, and it is the recommended target format for all your bitmapped images.

Each image starts out as a separate photographic print with its own unique palette. The process of scanning an image for use in a multimedia title varies somewhat according to the particular hardware and software in use, but always includes these steps:

Adjust Your Monitor

Your images may look great on your display, but if your production monitor is improperly adjusted the final image may not look right when displayed on other monitors.

The best way to adjust a production monitor is to buy a color bar generator that outputs pure RGB, and plug it directly into your monitor. You can also look for software that generates a color bar, and then adjust your monitor settings accordingly. Without these tools, adjustments are purely subjective as they rely solely on your ability to visually evaluate color.

Choose the Image Depth

Many scanners offer several image-depth settings. Because Windows 3.1 supports 1-bit, 4-bit, and 8-bit bitmaps, any palette can contain up to 256 unique colors. The quality of a scanned bitmap depends on how well a system can re-create the effect of a continuous-tone image using these 256 colors. Whenever possible you should always create and enhance bitmaps using large image depths.

Good color scanners can scan with a color resolution of up to 24 bits per pixel, allowing 16 million colors in the palette. Most scanning programs let you reduce the colors in the image from 24 to 8 bits or less. If you want to scan an image once and store the highest quality image possible, scan it at 24 bits and reduce it after you're totally satisfied with the results. If you don't need the original high-quality image, you might as well reduce it as you scan, because it will require far less space to store.

Adjust Image to Proper Size

Some scanners provide control over the size of the output image only through adjusting the resolution setting. For intended display in a VGA screen, 72 DPI is a good setting to start calibrating with. If your scanning software allows resizing of the image after it is scanned, always scan at the highest resolution possible.

Hint

Although paint programs allow you to resize images, building a digitized image of the correct dimensions with the scanning software gives you a better image. Paint programs make intelligent guesses when reducing or enlarging an image. In contrast, scanning software doesn't guess; it uses information from the original illustration to build the digitized image.

Identify Cropping Boundaries

Always prescan the image. Prescanning takes only a few seconds and provides a quick, low-resolution scan of the entire scanning bed. Prescanning your image lets you set cropping boundaries for the digitizing software and saves time during scanning. Prescanning is a feature offered on standard scanning programs.

After prescanning, eliminate any portion of the picture you don't want. This not only limits the size of the image file, it also reduces the total number of colors included in its color palette. You'll probably have to adjust the image's palette if you want to display it with other images; a smaller palette can simplify this process.

Scan the Image

Now scan in the image. After you've scanned the image, look at it and see what adjustments you might like to make. Scanner software sometimes includes a paint or draw package to clean up any problems introduced during the scan. If you have the time, cut out all unnecessary elements of each image, especially in the background. Again, this makes for a smaller image file and a smaller palette.

Transfer the Image

If you capture digital images on a different computer than your multimedia application development system, you'll need to transfer your images to the development platform. There are several ways to move images from one system to another, but using a network is probably the fastest and most efficient method if you are moving lots of large files.

Capturing with a Video Camera

Instead of using a scanner, you might want to capture images with a video camera—frame grabbing. The camera focuses on the image and then transfers that image to the PC through a special interface board that converts the analog video signal to a digital format. This digitizer simplifies the image by combining palette values and setting the resolution. It also converts the digitized image into a standard graphics format such as TGA or PICT, which can be easily converted by the Convert tool. This setup lets you grab images with the video camera that can be read and enhanced by software the same as a scanned image.

Many different types of cameras exist and they can deliver images in many different formats (such as direct video, composite video, and National Television Standards Committee (NTSC)). After you've captured the image, you still must convert and enhance the image for incorporation within your title. The following paragraphs summarize the steps involved in this process.

Note

A video camera usually digitizes images faster than a scanner, but it doesn't necessarily provide the best quality for the money. So, unless you're willing to get the best equipment, you might be better off buying a scanner for your basic image capturing.

Set up Your Copy Stand and Lights Properly

A proper setup and lighting can cut hours of image processing time. Using a copy stand as it comes out of the box invites trouble because quite often the lights are set to light the center of the stand. Often, one strong light (say, 1000 watts about five feet from the picture) will give you the proper, even illumination levels. Sometimes it is quite effective to tack the image to the wall and shoot it using a tripod-mounted camera. Although natural daylight is the best light for shooting video, it isn't necessarily the easiest to work with, nor is it always available.

Connect the Camera to the PC

To digitize images, you must plug a digitizer board into your computer, install the digitizer software, and connect the camera to the PC through the board. You may also want an extra monitor for viewing the camera image and some test equipment to ensure the best quality. Make sure all video equipment used is properly calibrated for color accuracy and reproduction.

Digitizers accept only RGB input, so you'll need to ensure your camera can output RGB. If you are capturing an NTSC signal, you'll need to convert it to an RGB signal before it reaches the digitizer by using a special NTSC decoder.

Other Video Sources

Digitizers can accept RGB input from sources other than cameras, but you should use a video camera whenever possible. Cameras provide signals with the greatest stability and highest resolution. The next best signal is usually a live feed from cable, broadcast TV, or videodisc. Use VCR images only as a last resort. VCRs produce highly unstable signals and low-resolution output (around 240 lines of resolution).

Capture Frames

Focus the camera on the object(s) whose image you want captured. Use the video capture hardware and software to grab the image and store it to disk.

All frame grabbers tend to distort the image slightly due to motion. The frame grabbing software is designed to compensate for this to some degree; however, for best results use still or slow-moving images. (Avoid grabbing when a VCR or videodisc player is in pause, mode, as that's when the image is the most unstable.)

If you are capturing an entire sequence of video frames for an animation sequence, you'll have to shrink the original frames to a size that can be played back at a particular rate by the hardware. The standard multimedia PC can play back at approximately 10-15 frames per second, with a frame size of approximately 100 pixels by 150 pixels by 8 bits. Reducing the frame size is probably best done with the original videotape before digitizing so that the entire sequence will then be a consistent size. Some video boards can shrink a full-screen video source. Otherwise, you may need to hire technicians in a TV studio at a greater cost.

Correct the Aspect Ratio

Your targeted aspect ratio is 4:3, representing the VGA monitor at 640:480. The aspect ratio of your camera or other video source is apt to be different, so you'll want to be sure the capture software you use can convert and correct the aspect ratio.

Scale the Image

By scaling the image down to less than full screen, you won't notice the lower resolution of the original video image. If you capture multiple video frames for an animated sequence, you'll have to shrink the original frames to a size that can be played back at a particular rate by the hardware. VidEdit, a tool that comes with Microsoft Video for Windows, allows you to resize video sequences.

Transfer Images to PC

If you capture digital images on a different computer than your multimedia application development system, you'll need to transfer your images to the development platform.

Enhancing Images

After you've captured the image and transferred it to your multimedia development system, you might still need to convert it to the Windows format. You might also want to make some minor changes to the image. For example, the scanner might have introduced minor distortions into the bitmap that you'd like to correct.

The BitEdit and PalEdit tools provided in this package let you enhance images in two basic ways:

- You can edit the images and their color palettes
- You can build a merged color palette for use with several images

You'll find the BitEdit tool acceptable for simple enhancements to 8-bit images. You may find you need more elaborate tools for image enhancements. You should consider touching up the image before converting the file to DIB format. Many excellent tools exist for both MS-DOS and Windows. Choose the tool that provides you with the best mix of features and capabilities.

Convert the Image to DIB format

The standard bitmap format for Windows and Windows-based applications such as Viewer is DIB. Windows knows how to read and display this format without any extra conversion. You should convert all images to this format as soon as they are final. Viewer titles can display bitmaps of a limited number of other formats, but to manipulate and merge palettes of multiple images, you must first convert them to DIBs.

Conversion to DIB happens automatically whenever you load an image into BitEdit. If you want to convert several images simultaneously, however, use the Convert tool. Convert provides batch processing capabilities, so you don't have to manually open and save each image file. For more information about the Convert tool, see the *Data-Preparation Tools User's Guide* in this package.

Crop and Size the Image

The preparation of your images for your title should be close to completion. You may need to make final adjustments to one or more of your images with gentle cropping, resizing, or other minor pixel and color edits. BitEdit can do cropping and sizing along with simple pixel editing and color adjustment.

Enhance the Image

Image enhancing software lets you touch-up imperfections in digital images. If you started with a good original illustration, you may have to do nothing more than adjust the brightness. This operation can be done on a section or on the entire image. You might also consider smudging and blending colors around the edges to produce a softened effect, or transposing or replacing certain colors with others to brighten or enhance the image. Always cut unnecessary elements from an image.

When you edit an image, always use the greatest image depth possible. For instance, when enhancing a 24-bit color image, use a software package capable of handling 24-bit colors. You should make all image enhancements and color changes to the original 24-bit image before you convert it to an 8-bit image, because information is always lost during conversion.

When you finish making your enhancements, you may want to save two versions of the image: a 24-

bit version and an 8-bit version. You'll use the 8-bit file for the titles you deliver today. Inventory the 24-bit file for the future—hardware able to display such images is just around the corner from being commonplace.

If your application can only display 16-color images, and you want to use full-color or black-and-white photographs or artwork, you should consider dithering your images if you want them to look good. BitEdit provides the capability to dither an image based on a targeted number of colors.

For more information about the BitEdit Tool, see the *Data-Preparation Tools User's Guide* in this package.

Adjust the Color Palette

Even though the content of the bitmap is ready to drop into your multimedia application, its palette may need some adjusting. For example, if you plan to display several images simultaneously, you'll need to edit or replace the palettes associated with those bitmaps. Your goal in this case is to create a color palette that makes all its associated images look good.

For additional information about PalEdit and the process of creating a merged palette, see the *Data-Preparation Tools User's Guide* in this package.

Inventory the Image

At this point you are ready to build these images into your title. Store the images for use. We recommend using some sort of data management system to organize and track the images and other data items associated with your application, as described in the Managing Data topic of this guide.

Animation and Video

Introduction

Quality images add tremendous value to a multimedia title. You can increase this value by making these images move. Multimedia Viewer plays back animation and video files through the Media Control Interface (MCI) in Windows.

Viewer supports motion-video files in Microsoft Video for Windows (AVI) format. The setup program for Viewer installs the required drivers to play Video for Windows files from Viewer titles.

Some animation authoring packages create files that play successfully in Viewer titles. Contact the following manufacturers to find out whether the animation files created by the indicated packages play successfully in Viewer 2.0 titles and to obtain the correct MCI drivers for playing the files under Windows:

Animator Pro
Autodesk
(415)332-8942

Director
Macromedia
(415)595-3101

Animation Works
Gold Disk
(416)602-4000

Animation and Video

Video vs. Animation

Motion video programs, such as Video for Windows, produce files that are like movies or video tapes: They can include any images you can put in front of a camera or capture from an existing source, and any sounds you can record with a microphone or obtain from an existing recording. Motion video programs attempt to play back these sounds and images synchronized together in perfect unison.

Animation programs allow you to manipulate text and images on a screen background in the same way that a director supervises actors on a stage. You decide on the scenery, then chalk out how the actors will move in front of it. You can add sounds and time them to go with the images with enough accuracy for narrative voice-overs and the speech of animated figures.

Animation and Video

Animation Programs

Predrawn backgrounds and characters are included with animation programs; you can also produce your own from drawings you import from another source. Text can be made to move dramatically, such as for attention-getting logos and introductions. Music or narrative can be added to emphasize or explain the images shown. Animation is especially suited to portraying complex processes and adding life to static graphs and charts.

All the data-preparation steps set out elsewhere in this guide for preparing images and audio are also required for producting animations. No special hardware is required to author or play animations, but animations running in Viewer do ask a lot of a PC; you might improve performance by keeping colors and movements simple, and settling for less than the highest sound quality.

Animation and Video

Video for Windows

Video for Windows can be used to play motion-video sequences in multimedia titles run on a personal computer. You can use Video for Windows to create live-action video, to display animations, and to present video slide shows.

Video for Windows stores files in the Audio/Video Interleaved (AVI) format. The "interleaved" in AVI refers to the way the format alternates between audio and video information. This interleaved structure leads to efficient playback, even on PCs with limited memory, without preloading lengthy audio segments.

Making AVI sequences involves capturing video clips, editing them, and compressing them for playback. The Video for Windows package includes the software tools needed for this process. You'll need an MPC with a 386 or better processor, at least 4 MB of RAM, and a large and fast hard drive. You'll also need a video capture board, a device that allows you to digitally record video to a file on you hard disk from a variety of sources, including video cameras, videotapes, and other existing video files.

Audio

Introduction

Audio rounds out multimedia titles by enriching the environment with music, sound effects, and speech. Each audio element can play a different role in a multimedia title. Music sets the mood and provides emphasis. Sound effects add variety and dash. Speech offers yet another way to present information.

This module presents topics discussing these aspects of using digital sound:

- The nature of sound
- Digital audio system technology
- Acquiring sounds for multimedia titles
- Software and hardware components of an audio preparation system
- The audio preparation process

With a multimedia PC, you have all the computer hardware and software needed to play digitized sound. With a few additional components, you can record and merge digitized sound into multimedia titles.

This module explains some of the issues involved in creating audio files for playback from Windows and Viewer. It describes in broad terms how to prepare audio files and offers suggestions for an audio preparation system. Creating good audio is as much art as it is science—nothing can replace expertise and experience. If you want good advice, find a good audio technician.

This module deals with waveform and Red Book audio. For information on MIDI sound, a separate technology, see the MIDI module of this guide.

Audio

What is Sound?

When something causes molecules of air to vibrate, your ear perceives this vibration as sound. For instance, when lightning strikes, the air around the flash becomes superheated and expands rapidly. This rapid expansion of molecules produces the change in pressure that eventually reaches your ears as thunder.

Sound is typically represented as an analog (continuous) waveform. The waveform describes the vibration of the air molecules. The plucking of a guitar string not only visually resembles a waveform, it produces them as well.

The distance between the top (or bottom) of the waveform and its baseline is known as its *amplitude*. Amplitude indicates the volume of the sound. The points in a waveform with the highest peaks and deepest valleys sound the loudest; a flat line in a waveform indicates silence.

All waveforms divide into *periods.* A period is the distance between two consecutive peaks in a waveform. The *frequency* of a waveform is determined by the number of periods that occur in one second. One period per second equals one hertz (Hz). One thousand periods per second equals one kilohertz (kHz).

For more introductory information, see the following topics:

- Making Sound Digital
- Quality vs. Size of Digital Waveform Files
- Compact Disc Digital Audio
- Choosing a Fidelity Level

Audio

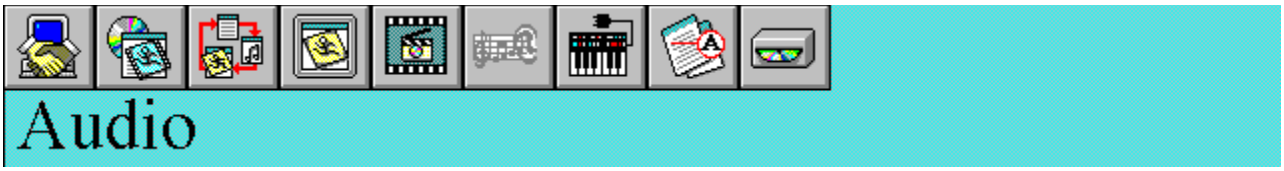
Making Sound Digital

The analog signal produced by radios, telephones, and other familiar devices is as continuous and variable as a waveform itself. In these devices, the electrical signal varies just as does the sound it represents. Digital sound signals, by contrast, do not mimic the shape of the waveform—they describe it in numerical terms. A digital sound signal is a series of numbers describing the sound at rapid intervals of time.

Theoretically, an analog signal is more accurate, because it is an uninterrupted representation of the waveform at every instant. In the real world, digital signals often deliver more accurate sound to our ears. The numbers in digital signals are built from the simplicity of ones and zeros—the signal is either on or off. In the same way that you could tap out a message with perfect accuracy in Morse code over a telephone line so poor your voice would be too garbled to be understood, digital signals come through clearly despite interference and imperfections in the system delivering them. Background noise becomes a part of analog signals, but is ignored when the signal is digital.

An analog waveform is translated into digital form by taking separate measurements of the waveform (*samples*) at fixed intervals. Each sample is mapped to an integer value, which is then stored. These integer values can then be used to re-create the original waveform: its amplitude by the measurement each sample contains, and its frequency by the pattern of amplitudes over the intervals at which they were recorded. The result is quality sound practically indistinguishable from the original.

Compact disc audio is the highest quality format, but produces the largest files. Other formats store digital sound files more economically, but with some trade-off in quality.



Quality vs. Size of Digital Waveform Files

Three characteristics can determine the quality and size of a digital waveform file: the frequency of the samples, the amount of information stored per sample, and the number of channels recorded.

Sampling Rate

Samples are taken at the same frequency (*sampling rate*) to divide the waveform into identically sized portions. The more portions (i.e., the higher the frequency), the more quality obtained and disk storage required. More portions also means higher tones in the sound will be recorded; for example, 11.025 kHz sampling only captures tones lower than 5.513 kHz in frequency.

Of course, this is only an approximation; inevitably some information present in the original waveform gets lost in the process. This is why the frequency of the samples affects so directly the quality. The more frequent the samples, the less information lost in approximation.

The three standard sampling frequencies are 44.1 kHz, 22.05 kHz, and 11.025 kHz.

Sample Size

The amount of information stored per sample (*sample size*) specifies the precision with which sample is measured. Information per sample is derived by vertically dividing each waveform sample into equal units. An 8-bit sample measures the sound with a fairly short ruler divided into 256 equal units. A 16-bit sample uses a longer and much finer ruler divided into 65,536 equal units.

The finer the divisions in the "ruler," the more accurate the sample is. And the longer the ruler, the louder the sound that can be accurately measured. Of course, more information also requires more storage.

The number of units between the baseline and the upper limit of the waveform is sometimes referred to as its *dynamic range.* For 8-bit samples to be as accurate as possible, the waveform must have a dynamic range that covers all (or most) of the 256 units. If the waveform's dynamic range only covers 128 units, precision (and quality) is reduced—as though only 7-bits were used per sample.

Number of Channels

The number of sound channels specifies whether a recording produces one waveform (referred to as *monaural* or *mono*) or produces two waveforms (referred to as *stereo*). Stereo sound can offer a richer listening experience than mono, but also requires twice the amount of storage.

How Much Storage is Required?

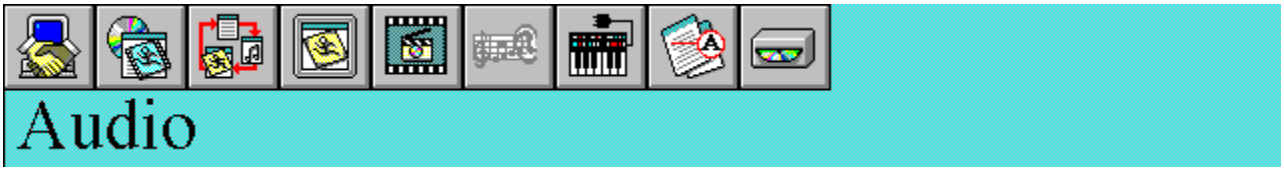
Digital sound files are large, no matter what quality you choose, but the lower sampling rates produce much smaller files than the higher sampling rates. Use this formula to estimate storage needs for

audio:

(sampling rate * bits per sample)/8 = bytes/sec

For example, a one-minute monaural sound clip requires the following space:

Sample size	Sampling rate	Space required
8 bits	11.025 kHz	0.66 MB
8 bits	22.05 kHz	1.32 MB
16 bits	44.1 kHz	5.292 MB



Compact Disc Digital Audio

The digital sound format used by audio CDs can also be used in applications for Windows. Compact disc digital audio (CD-DA), also known as *Red Book audio,* uses a sampling rate of 44.1 kHz and stores 16 bits of information for each sample. It is technically similar to, but not interchangeable with, ordinary waveform audio.

Multimedia PCs can play standard Red Book audio CDs. Windows controls the audio playback, but the audio is not played through the computer; it is played through special chips in the CD-ROM drive. This capability provides a potential source of high-quality sound for multimedia PC title developers.

You can include CD-DA with other information in a CD-ROM multimedia title for use with Windows and Viewer. This lets you use the highest quality audio in your titles without requiring any special hardware or software. Before making this decision, however, you need to weigh the increased quality against the following factors:

- Red Book audio requires the entire processing power of the CD-ROM drive—your title can't transfer any other data when CD-DA is being played.
- Red Book audio uses a lot of space on the disc. Fifteen minutes of CD-DA sound can require about 80 MB of storage.
- Red Book audio can't be edited with the same tools as waveform audio files, such as the WaveEdit tool that comes in this package.

CD-ROM titles that use Red Book audio are often called *mixed mode* CD-ROMs. Sound stored in CD-DA format is separated from the other data on a CD-ROM and requires a separate access when retrieved. Your title must preload program, image, and other data into memory (or into a cache area on the hard disk), and then dedicate the CD-ROM drive's circuitry to access the CD-DA sound as the title runs.

Red Book audio files at 16 bits and 44.1 kHz don't have the preloading requirement and tools-compatibility problem of waveform audio. And while Red Book audio preoccupies a CD-ROM drive, Red Book-quality waveform audio requires a lot of CPU power and hard-disk space.

Choosing a Fidelity Level

Choosing the sound fidelity level of a title means that you must balance sound quality against the space needed to store the sounds for your application.

- From an audio perspective, you need to have a reasonable fidelity level for the sound used.
- From a resource management perspective, you have a limited amount of storage space for sound files.

The best quality sound you can use in the multimedia PC is CD-DA (44.1 kHz) format. This format is particularly well-suited for music or language applications where nuances of pronunciation are critical. Red Book audio requires the most space on a CD and it uses up the entire bandwidth of a CD-ROM drive to play it. You will always have to preload images and other data off the CD before you start playing a Red Book passage.

A good general-purpose sound quality to use is the 8-bit, 22.05-kHz format. If you use good recording techniques, you should be able to get quality comparable to AM radio.

At the low end of the multimedia PC sound spectrum is the 8-bit, 11.025-kHz sound. Generally, you'll want to use this sampling rate when sound is not a critical or prominent feature of your application. This is adequate for prototyping, titles that use voice narration, or for low-frequency sound effects. However, even the best recordings can sound dull and fuzzy at this sampling size/rate. You'll fare better if you choose recordings that don't use bright, high-pitched sounds.

Whatever format you choose, always start with the highest quality you can record—44.1 kHz—and then later convert the sound to the lower sampling rates with the WaveEdit tool included in this package. This way you'll always have a high-quality archive file to go back to.

Acquiring Audio

Narration, sound effects, and music often originate as studio-recorded analog data, although they can also be recorded digitally. No matter how it originates, all sound data destined for multimedia titles must eventually be digitally sampled and stored in the Microsoft waveform format or CD-DA (Red Book) format for playback.

No single method of acquiring audio will meet all your needs. Experiment with different approaches and tactics until you find the best mix for your situation. The following three alternatives are worth exploring:

- Developing Your Own Recordings
- Purchasing Production Music Libraries
- Hiring a Digital Sound Studio

Developing Your Own Recordings

Digital audio sampling can be painfully accurate. It picks up every sound blemish you introduce during the recording session, even those subtle distortions caused by analog electronics.

If you're planning to use 11.025 kHz or 22.05 kHz samples, you can use a desktop audio recording system. With a desktop audio system, you can remove or alleviate some of the subtle glitches in the original with editing or when you convert the original recording to the lower-resolution formats. The WaveEdit tool included in this package can serve as your desktop recording and editing software.

If you intend to use full-bandwidth CD audio, hire a studio that specializes in digital audio recording. For more information, see the "Hiring a Digital Sound Studio" topic later in this sequence.

Using the WaveEdit application included in this package, you can record in several formats and perform simple edits on the final waveform. The file can then be saved in the Microsoft waveform format. To record using another recording system, you'll need to run the recording application and set the recording rate. You'll end up with a waveform that you can edit and mix with other sound.

One of the best ways to ensure a clean, distortion-free signal is to record the sound directly from the source.

One of the nastier elements of digital recording is a distortion, called clipping, that occurs at loud segments (high amplitudes) of the music. It happens when you record with too much volume, or when you digitize an analog source outside the tolerable range (analog electronics tolerate this sort of distortion much better than digital electronics). Several recording applications display the clipped region when the amplitude of the source waveform is too high. Other products show gauges or waveforms going off the scale or outside the display region. Pay attention to these signs and reduce the amplitude of your sounds as necessary.

It is best to record your sounds at the highest possible sampling rate to preserve the maximum information, the highest quality being 44.1-kHz samples at 16 bits per sample. For more information on WaveEdit, see the *Microsoft Multimedia Viewer Data-Preparation Tools User's Guide.*

Purchasing Production Music Libraries

Professional sound libraries are available from a number of companies. Originally intended for the radio, television, and motion picture industries, these libraries include a wide range of digitally mastered music clips and sound effects.

Music libraries include fully orchestrated entries as well as narrated versions that cut out lead instruments to allow voice-overs. The distribution medium for these libraries is audio CD, which provides a direct path to your multimedia PC sound-preparation system. Purchase options for sound libraries vary by company and may include individual CDs, entire libraries, and subscription services.

This method of acquisition offers high-quality audio at low cost, but it limits your ability to tailor the content to the needs of your title.

Note

Don't forget that you are breaking the law if you record and use copyrighted material without securing the rights from the publishers.

Hiring a Digital Sound Studio

Hiring a digital sound studio allows you to obtain Red Book-quality sound clips from scratch and provides you with at least two advantages over the previous alternatives: You have total control over content, and you can use the clips as you see fit without regard for royalties and copyright concerns. The downside: Be prepared to pay for these benefits. This type of expertise isn't cheap.

To do the job properly, you'll have to rent specialized equipment and contract for the services of professional audio engineers and, perhaps, composers and musicians.

Preparing Audio

Once you have acquired all the audio elements for your titleall the necessary voices, sound effects, and musicyou can then prepare the files for use. The audio preparation process consists of several phases:

- Setting Up the Audio Preparation Environment
- Converting Audio
- Editing Audio
- Storing Audio

Setting Up the Audio Preparation Environment

The standard multimedia PC can handle the playback of audio quite well. But to prepare this audio for use in a title, you'll need more powerful software and hardware. The following sections describe some of the factors to consider when setting up your audio preparation environment.

Sound-Preparation Software

When choosing your sound-preparation software, first decide exactly what you need. Some products perform standard functions for recording and editing waveforms. Other products provide a digital signal processing laboratory that includes the standard functions, as well as advanced capabilities that can include cross-channel mixing and frequency analysis.

The Viewer Publishing Toolkit includes WaveEdit—a simple sound editor with recording capabilities to let you record in the 8-bit and 16-bit waveform format. WaveEdit also includes conversion utilities for Macintosh AIFF and PCM formats. The Convert tool also supports the conversion of audio formats.

Features included with sound-preparation products appear in the following table. The left column shows standard features found in all the products. The right column identifies advanced features found in higher-end products:

Standard features	Advanced features
Digital waveform recording up to frequencies of 22.05 kHz	Digital waveform recording at frequencies up to 44.1 kHz
Visual waveform editing (cut and paste waveform sections)	Cross-channel mixing
Mixing waveforms together	Adjusting waveform tempo without pitch change
Inserting silence fades (in and out)	Adjusting pitch
Adjusting amplitude	Defining amplitude envelopes for a waveform
	Mixing more than two channels of waveform data
	Frequency analysis
	Defining playlists that sequence waveform segments for playback

Once the sound file is complete, the file may need to be converted to a format supported by the multimedia software. Viewer supports Microsoft waveform (.WAV) and CD-DA (Red Book) audio formats.

Sound-Processing Hardware

Audio preparation requires a lot of horsepower and disk space, so you better buy plenty of both when acquiring hardware for your audio preparation system. Consider these issues when acquiring a system:

- Picking the right central processing unit (CPU)
- Getting enough hard disk space
- Choosing an analog-to-digital converter
- Picking a microphone
- Acquiring tape backup

CPU

Editing audio data is a processor-intensive operation, and requires quick CPU and disk controller performance to handle the volume of data managed and collected. The base-level Multimedia PC Specification requires an 80386SX processor. This would not be adequate for audio preparation. Look for at least an 80386DX or better processor. Configure your PC with at least 4MB of RAM; consider adding as much additional RAM as can be conveniently and economically installed in your PC. You may want to use some of that memory for a RAM disk to store temporary data during the data-capture phase.

Hard Disk

Sound files are large and fill up a hard disk quickly. Provide your system with sufficient disk storage (at least 300-600 MB) to record, edit, and convert the sound clips used by your application.

Analog-Digital and Digital-Analog Converters

These devices are often delivered on a PC interface card. An analog-to-digital converter (ADC) converts incoming analog signals to discrete samples at regular time intervals. A digital-to-analog converter (DAC) converts outgoing digital signals to analog, for use by an amplifier, speakers, or other analog devices. The Multimedia PC Specification establishes both an ADC and a DAC as standard equipment.

Capabilities of various available ADCs and DACs vary. For example, the interface card containing the converters may also contain additional circuitry for digital signal processing, especially in high-end products. A digital signal processor (DSP) chip provides added punch for such tasks as frequency analysis.

If you plan to record and play Red Book-quality waveform sound clips, verify that the converters can support 16-bit samples at a 44.1-kHz frequency.

Microphone and Cables

A good original recording source and good acoustics are part of making a good sound. But, if you are planning to record anything live with a microphone, purchase a good one—it can make a distinct difference in your final recording.

Microphones are very specific to their application. When you're ready to buy a microphone, tell the experts how you intend to use it and have them recommend the best type of microphone for that particular job.

Additionally, don't go bargain hunting when picking out cables for your audio equipment. Cheap, thinly insulated cables pick up static from the equipment, which makes your audio sound worse. Buy quality

cables—they're well worth the investment.

DAT Tape Deck

If you are recording full-bandwidth, Red Book-quality audio and you are using a 100-MB hard disk, you're going to run out of space in about 19 minutes of recording. DAT cassettes hold 4 hours of the same type of audio. With all data you need a backup storage system, but this is particularly important with audio data, just so you can get all your work done.

Converting Audio

If you already have a Macintosh-based audio preparation system, you may want to continue to create and edit audio with that system. The most common format for Apple audio files is AIFF. After you finish editing the files, you'll need to transfer them to a PC and convert them to work in the Windows environment.

The Convert and WaveEdit tools include an AIFF-to-waveform format converter. After you transfer the audio files from the Macintosh to the PC, run the converter to translate your audio files into waveform format. Waveform format can use 11.025-kHz, 22.05-kHz or 44.1-kHz samples, storing 8 bits or 16 bits of information per sample. The 8-bit, 22.05-kHz sound is high enough quality for most applications, and is often compared in quality to AM radio.

Windows and Viewer work only with digital audio, so if you have any source audio in analog format, you'll need to translate the analog signals into a digital format. Recording such sources in waveform format with WaveEdit is one way to accomplish that translation.

Once they are in waveform format, your multimedia title can access and use the audio files just like any other resource.

Editing Audio

When you have captured all the audio pieces, edit them to achieve the results you want. The editing process involves such aspects as rearranging and combining sounds, changing amplitude, and eliminating distortion.

Various software packages for music creation, sound effects, and digital mixing exist to let you edit the audio elements—either as separate entities or as an integrated soundtrack—and then output the finished product as files on disk.

WaveEdit provides the following editing capabilities: setting volume, fading in and fading out during transitions, and mixing several channels. WaveEdit can get you started, but it isn't intended to serve as a full-featured audio editing tool. Other sound recording applications contain a fuller set of audio editing capabilities.

Storing Audio

After you create and enhance the audio files, store and inventory the files. Note that sound files are very large. You'll need a very large hard disk if you plan to do a lot of recording. You should consider using digital audio tape as well.

MIDI

Introduction

Along with the rich capabilities of waveform audio and CD-DA, Windows version 3.1 supports the use of MIDI files within multimedia titles. The standard multimedia PC platform can play MIDI files through either an internal synthesizer, or through an external synthesizer attached to the machine's MIDI port.

This capability expands your options in including sound with your titles. MIDI files can include any type of music, from original compositions to popular music soundtracks, as well as special audio effects. The minimal storage requirements of MIDI make it a welcome addition to your menu of audio alternatives.

This module introduces MIDI terms and technology, describes the characteristics of MIDI in the multimedia PC environment, and offers some brief guidelines for authoring MIDI files for use in your titles. If you adhere to the guidelines in this module, the music you compose will work on all classes of multimedia PCs—from those that only meet the base level of the specification to those that include extended MIDI capabilities.

MIDI

What is MIDI?

MIDI stands for Musical Instrument Digital Interface. Established in 1982, MIDI specifies an international standard for digital music:

- It specifies the cabling and hardware for connecting electronic musical instruments and computers from different manufacturers.
- It specifies a communications protocol for passing data from one device to another.

Any musical instrument can become a MIDI device if it has a microprocessor to process MIDI messages, and includes the appropriate hardware interfaces. MIDI devices communicate with each other by sending *messages* through this interface. MIDI messages are actually digital descriptions of a musical score−complete with the sequence of notes, timing, and instrument designations called *patches*. When a set of MIDI messages is played through a music synthesizer chip, the synthesizer interprets these symbols and produces music. By definition, a multimedia PC includes an internal synthesizer along with standard MIDI port connections.

Basic MIDI Terminology

MIDI has sprung from both music and computing, and uses terminology that can seem intimidating to the uninitiated. This topic sets out a short glossary of some of the terms you'll encounter in this module. For more introductory information, see the following topics:

- MIDI Ports
- MIDI Cables
- MIDI Synthesizers
- How a Message Becomes Music

Channel Mapping

Channel mapping translates a MIDI channel number from a sending device to an appropriate channel for a receiving device. For example, drums authored on channel 16 can be mapped to channel 6 for a drum machine that only receives on channel 6.

Channels

The MIDI Specification provides for 16 channels of data—each channel addressing a separate logical synthesizer. Microsoft uses channels 1 through 10 for extended synthesizers and uses channels 13 through 16 for base-level synthesizers.

Instrument

A specific sound that a synthesizer can reproduce. The patch number and sound qualities of an instrument may vary from one synthesizer to another. For example, most synthesizers can play a piano sound, but it is likely to sound quite different and use a different patch number on different synthesizers.

MIDI File

A standard file format for storing recorded MIDI information. A MIDI file contains notes, timing, and instrument designations for up to 16 channels. The file contains information about each note, including the key, channel number, duration, volume, and velocity (how quickly the key travels to its down position when struck).

Patch Mapper

Software that reassigns an instrument patch number associated with a specific synthesizer to the corresponding standard patch number specified in the Microsoft standard MIDI patch assignments. The Windows 3.1 MIDI Mapper maps instrument patches to any MIDI devices.

Polyphony

This refers to the maximum number of notes that can be sustained by a synthesizer at once. For example, a four-instrument synthesizer with six-note polyphony can simultaneously play six notes distributed among four different sounds—perhaps producing a four-note piano chord, a flute, and a violin.

Sequencer

A computer program or electronic device designed for MIDI composition, which allows recording, playback, and editing of MIDI events. Most sequencers can import and export MIDI files.

Synthesizer

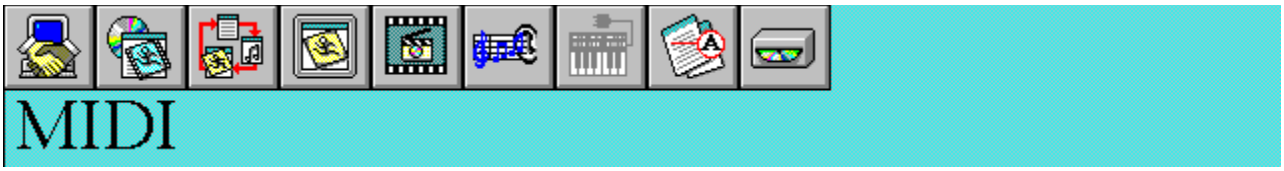
An electronic device that uses a digital signal processor (DSP) or other type of chip to make music and sounds. A DSP creates and modifies waveforms and then sends them out through a sound generator and speakers. The quality and range of sounds made by a synthesizer depend on several factors: the number of individual waveforms (or *instruments*) the synthesizer chip can play simultaneously, the capabilities of its control software, and the memory size in the synthesizer circuitry.

Timbre

Pronounced tamber. This refers to the tone quality of a sound, which is determined by the combinations of frequencies from which it is formed. In more casual usage, it refers to the unique sound associated with a particular instrument. Bass, piano, and violin sounds are each examples of timbres.

Track

A MIDI file concept of separate, parallel groups of MIDI data, usually separated by channel. Format 0 MIDI files merge these tracks into one track; Format 1 MIDI files preserve the different tracks.



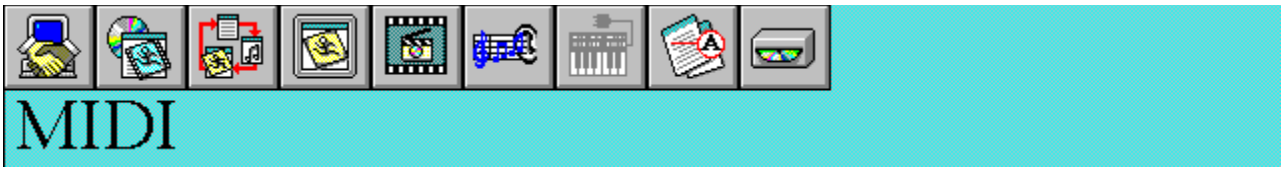
MIDI Ports

A MIDI device may have one or more of the following ports: MIDI In, MIDI Out, and MIDI Thru. A multimedia PC has all three. Each port has a specific purpose in sending, receiving, or relaying MIDI messages between devices. This design enables you to connect multiple MIDI devices that can be controlled simultaneously.

	MIDI In	**MIDI Out**	**MIDI Thru**
Receives MIDI messages from other MIDI devic		Transmits original messages generated from the device.	Propagates messages received on MIDI In ports to other connected MIDI devices.

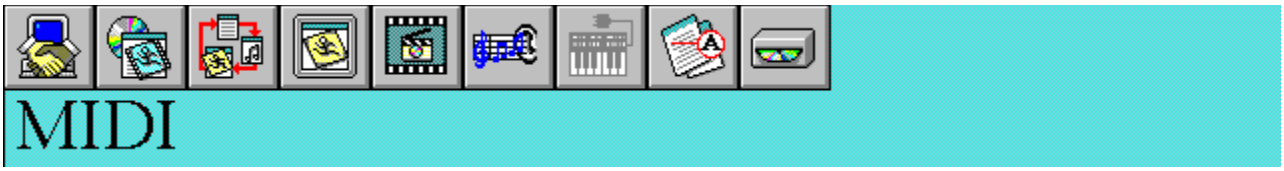
e
s.

Sends MIDI messages to other devices.	Sends MIDI messages to other devices.



MIDI Cables

The MIDI In/Out/Thru ports all support the standard MIDI cabling. A MIDI cable consists of a shielded, twisted-pair wire with a male 5-pin DIN plug connected to each end of the wire.



MIDI Synthesizers

The same MIDI file can sound as different on synthesizers from different manufacturers as the Beatles on vinyl and the Beatles on your building elevator. Although it is difficult to clearly measure certain differences between synthesizers, you need some guidelines so you can create MIDI files to play on all multimedia PCs. For this purpose, two types of synthesizers have been defined: *base-level synthesizer* and *extended synthesizer*.

All multimedia PCs provide at least a base-level synthesizer. Users can enhance their computer by adding internal or external synthesizers, which can be either base-level or extended synthesizers.

The distinctions between base-level and extended synthesizers depend solely on the number of instruments and notes they can play, not on their quality or cost. The following table shows the minimum capabilities of base-level and extended synthesizers

Synthesizer	**Melodic Instruments**		**Percussive Instruments**	
	Number	**Polyphony**	**Number**	**Polyphony**
Base-level	3	6 notes	3	3 notes
Extended	9	16 notes	8	16 notes

Polyphony is the number of notes the synthesizer can play simultaneously. The polyphony expressed above applies to each group of instruments, melodic and percussive.

Melodic instruments are each on different MIDI channels; percussive instruments are key-based, all on a single MIDI channel.

When a user adds a synthesizer, the user must configure the MIDI Mapper to use the new device, or the instrument sounds will not be correct when playing MIDI files. The MIDI Mapper Control Panel applet allows a user to configure the MIDI Mapper as needed.

MIDI

How a Message Becomes Music

In addition to physical connections, the MIDI specification defines standard messages that MIDI devices use to communicate with each other. These messages identify the events to define and reproduce music with one or more MIDI devices. The message content defines events such as striking a note or changing an instrument from a flute to an oboe.

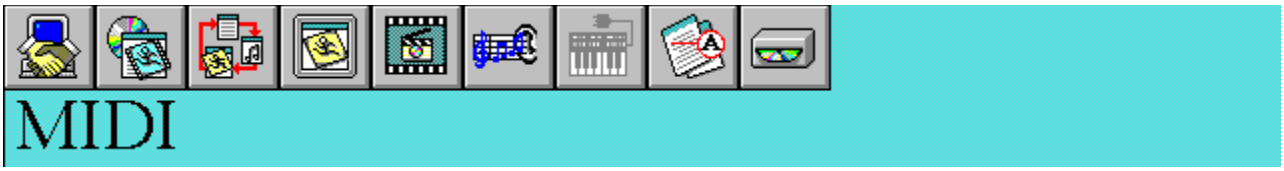
The set of MIDI messages and data values that define and reproduce a song are stored in *MIDI files*. Each MIDI file can store up to 16 music channels of information. You build a MIDI file with a *sequencer*, which captures MIDI messages and stores them in a file.

When you play a MIDI file, the sequencer sends MIDI messages from the file to a synthesizer, which converts messages into sounds of a specific instrument, pitch, and duration. A synthesizer generates music and sound with a DSP or other type of chip by creating and modifying waveforms and sending them out through a sound generator and speakers.

Timbre is the tonal quality that distinguishes instruments from one another. Some synthesizers synthesize sounds from parameters that define the timbre of an instrument. Other synthesizers use digitally recorded samples of the original instruments and modify these sounds in memory for volume and pitch changes. Sounds produced synthetically are not as realistic as those produced from the original samples. Multimedia PCs may use either type of synthesizer.

The MIDI message sent to the synthesizer identifies which timbre to use. To find the timbre, look at the patches defined by the MIDI Manufacturers Association (MMA) General MIDI Mode specification (shown later in this chapter).

If a synthesizer is polyphonic, it can play several sounds at once. Polyphony differs slightly from the number of timbres a synthesizer supports. A four-voice synthesizer with six-note polyphony can play six notes simultaneously, but must distribute the sounds among a maximum of four timbres—for instance, a three-note piano chord, one note with a flute, one note with a bassoon, and one note with a violin.



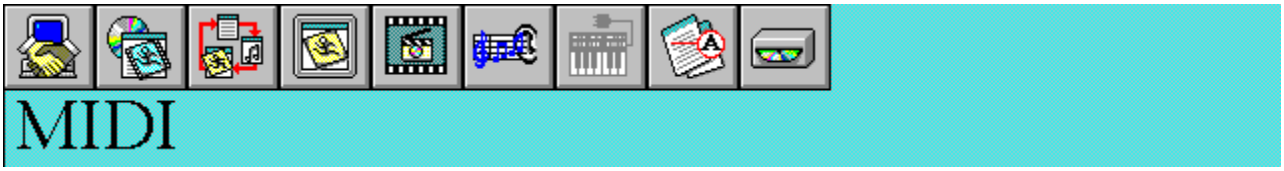
When to Use MIDI

With all the capabilities inherent to waveform audio, you might ask: Why bother going through the trouble to understand and use MIDI? The reason is that MIDI files offer some very compelling benefits over waveform audio:

- Since a MIDI file is a series of instructions and not a waveform, it requires much less disk space. For example, a typical 8-bit, 22.05 kHz waveform lasting 1.8 seconds might require 41K. A typical MIDI file lasting two minutes could require less than 8K.
- Because the size of the MIDI file is so much smaller, you can pre-load MIDI files much easier than you can waveform files. This gives you flexibility when you design your title and specify when music occurs.

There are several situations where using a MIDI score is preferable to using waveform audio. The following table offers some general scenarios where you'd choose one form of audio over another.

Use Waveform Audio When...	Use Compact Disc Digital Audio When...	Use MIDI When...
You need to play voice-over narration or natural sound effects.	Your title requires full CD-DA quality audio.	You need to play music of more than a short duration of reasonable quality.
You need to load other data from the CD drive simultaneously.	You need the full CPU bandwidth for some task other than using the CD drive (when CD-DA audio is playing, you can't load anything from the CD drive).	You need to load other data from the CD drive simultaneously.
You want to store less than one minute of sound on the hard disk.	No hard disk storage of sound is needed.	You want to store more than one minute of music on the hard disk.
You have plenty of space available.	You have plenty of space available.	Space available on your CD-ROM disc is limited.



Acquiring MIDI Scores

Like voice and special sound effects, music is critical to a multimedia application because of the effect it can have on the end user's perception of your product. People are extremely sensitive to any type of sound and are unforgiving if the music composition isn't constructed well. It's critical to pay attention to quality.

You can acquire MIDI scores in several ways:

- Purchasing MIDI compositions
- Hiring a MIDI sound studio
- Recording your own MIDI scores

Purchasing MIDI Music

Just as with digital audio, a variety of different MIDI libraries are available. These libraries include sound effects, transitional music, and full-fledged re-creations of popular melodies. Like anything else associated with building a multimedia title, make sure you have the legal rights to sell and distribute any MIDI clips used in your title.

Hiring a MIDI Sound Studio

Hiring qualified electronic musicians on a contract basis may prove more effective for individual projects than developing in-house resources. The professional expertise will be reflected in composition quality. In addition, professional musicians will have their own equipment (keyboards and synthesizers) and may prefer to use it.

Recording Your Own MIDI Scores

If you plan to use MIDI extensively, you may want to develop the expertise in-house to create and refine musical compositions with MIDI. With this approach, you gain complete control over the development of the music. You also eliminate royalties and copyright issues that accompany the use of existing music.

Along with qualified personnel, you'll need tools: a keyboard synthesizer to compose and play the original score and a computer with a MIDI sequencer program to record the timing, instrumentation, and multiple tracks of the composition. The next several topics discuss the types of hardware and software you'll need.

MIDI Authoring System

The software and hardware lists in following topics identify the types of equipment you'll need if you intend to create MIDI scores for your product. You'll need fewer software and hardware components to prepare MIDI than you'd need to prepare digital audio. MIDI sequencers, keyboards, composition programs, and other MIDI equipment abound in the market. In addition, MIDI files are extremely efficient in terms of disk space usage. You don't have the massive additional disk storage requirements with MIDI that you have with digital audio.

- MIDI Software
- MIDI Hardware

You should, however, consider hiring a knowledgeable musician before you invest—he or she may have a suitable system already. That way you not only gain the benefit of experience, you also might save money on equipment.

MIDI Software

MIDI software applications for the PC consist of one primary application: a sequencer. Rudimentary characteristics for sequencers and other supplemental applications follow.

Sequencer

A sequencer program provides MIDI message recording, editing, and playback capabilities—making it essentially a multitrack tape recorder for MIDI instruments. The following list identifies the base functions a sequencer should provide:

- Importing and exporting of sequences as MIDI files in formats 1 and 0
- Settings to control individual tracks; controls for each track should operate independently of other tracks
- A *Current Position Indicator* to indicate the current position in the MIDI file
- Recording and editing capability in real time and step time. Real-time operations capture data as it's played on a synthesizer keyboard. Step-time operations capture individual MIDI instructions as you enter them from the multimedia PC keyboard
- *Quantizing* to correct timing and synchronization inconsistencies
- Support for external MIDI devices and the ability to accommodate extensive MIDI configurations

MIDI Patch Mapper

To help ensure that MIDI files authored on one synthesizer sound the same when played back on another, Windows 3.1 includes MIDI mapping functionality as part of its core system capability. The MIDI Mapper lets you identify the MIDI devices in the system and performs the following functions:

- Remaps or mutes channel data
- Independently routes channel data to any MIDI port in the system
- Remaps patch numbers
- Remaps key numbers (intended primarily for key-based percussion)
- Scales channel/volume controller messages

These standard patch services enable Windows 3.1 to provide device-independent MIDI file playback for applications, and ensure that Viewer (using MCI) plays MIDI files correctly.

MIDI Hardware

All multimedia PCs provide base-level or extended synthesizer capabilities. In developing MIDI compositions for your applications, you'll also need a MIDI keyboard and may want to include one or more synthesizers in your development system. The following pieces of hardware will provide your system with the capacity to develop MIDI compositions for your multimedia titles.

Base-level MIDI Synthesizer

The standard multimedia PC includes a MIDI interface, and at least a base-level synthesizer is included in the hardware and supported through Windows version 3.1.

Using the synthesizer in the multimedia PC is the most direct approach for developing MIDI compositions. You can compose exactly what the user will hear. Testing your MIDI files on several multimedia PC synthesizers will give you a good idea of how playback sound can vary depending on synthesizer capability.

A MIDI keyboard

The MIDI keyboard will generate MIDI commands to produce music. MIDI keyboards are packaged in at least two configurations: a master keyboard that connects to other MIDI devices and a keyboard-synthesizer.

A master keyboard connects to the synthesizer in your computer and supplies the synthesizer with MIDI messages to produce sound. Master keyboards generally can control several MIDI devices.

In comparison, the keyboard-synthesizer can perform the base functions of a master keyboard, and also can operate as a self-contained unit.

Building a MIDI Score

A MIDI score is built in layers, using the MIDI sequencer very much like a multitrack tape recorder is used in a typical recording studio. When you create a MIDI song using one instrument, you can overlay this song with more instruments to produce the melody, harmony, and percussion.

When creating a MIDI file for a multimedia PC, make sure that you create a base-level version on channels 13-16 and an Extended version on channels 1-10. Read the topic Authoring Device-Independent MIDI Files, later in this module, to find out why this is important and how to create a proper file.

The following topics cover the general steps involved in creating a MIDI score for Windows and Viewer:

- Composing MIDI Tracks
- Recording MIDI Tracks on a Sequencer
- Editing Each MIDI Channel
- Modifying Characteristics of a MIDI Score
- Storing MIDI Compositions

Composing MIDI Tracks

Most musicians develop the melody, bass harmony, and percussion of their composition from a keyboard by playing, recording, playing back, and editing each component until it sounds just right.

Recording MIDI Tracks on a Sequencer

To create the final composition, each track must be recorded using a sequencer. Certain designated channels must be used to ensure device-independent playback on multimedia PCs. See the topic later in this module, Authoring Device-Independent MIDI Files, which discusses this topic in detail. In general, you'll need to build your composition to work for both base-level and extended synthesizers.

Editing Each MIDI Channel

Sequencers typically maintain each channel's data as a separate track, allowing you to play them back and edit them independently. Go through and edit all the channels until satisfied with the quality of each.

Modifying Characteristics of a MIDI Score

If you compose your MIDI score using the synthesizer in a standard multimedia PC, you can be reasonably certain that the instrument patches and volume levels will work fine for other multimedia PCs. Otherwise, you should translate your patches to the standard MIDI patch specifications defined in the topic, "Standard MIDI Patch Assignments," later in this module, and test playback on a multimedia PC synthesizer.

Another modification you might want to make at this stage is to specify whether notes in the channel play on the left or right speakers, or in between.The general process for modifying a channel message to include stereo goes like this:

1. Set the instrument patch to the appropriate patch number as defined in the General MIDI Mode standard (shown later in this chapter).
2. Set the volume of the channel.
3. If you want stereo, set the Pan Controller Message to the appropriate value between left and right.

Storing MIDI Compositions

MIDI files can be stored in three file formats: 0, 1, and 2. Most sequencers can export data in MIDI file format 0 or 1. Save the sequence as a format 0 or format 1 MIDI file—Windows 3.1 supports only file formats 0 (single track) and 1 (multiple track). It is recommended that you use format 0, especially for CD-ROM, because it minimizes both RAM usage and the number of seeks. Once you have saved the MIDI file, you are ready to include it in your title.

Converting Existing MIDI Files

You can also use MIDI files composed on a different system. Here are the general steps to prepare and convert these files for Windows 3.1:

- Rechannelize the MIDI data.
- Convert patch numbers to the General MIDI Mode specification.
- Set a volume level.

Rechannelize the MIDI Data

Duplicate the most important melodies and harmonies of the song in the first three channels for both the extended and base-level synthesizers. Make sure the channel numbers and polyphony match the guidelines for MIDI files under Windows 3.1 (channels 1 through 10 for an extended synthesizer, channels 13 through 16 for a base-level synthesizer).

Convert Patch Numbers

The final MIDI file must have patch numbers that match valid Microsoft MIDI patch assignments.

Set a Volume Level

The relative volume levels may be different in every synthesizer, and so, to get a truly accurate reading, you'll want to play the file through the synthesizer in a multimedia PC.

Start with a volume setting of 80 for normal listening levels. For quieter or louder playback volume, change the value accordingly. Volume levels range from 0 through 127. You will want to adjust the volume in every channel. This is especially important when authoring your MIDI sequence on a system different from the final playback system.

Authoring Device-Independent MIDI Files

MIDI specifications are a coordinated effort to provide standard communications protocol and connections, and allow devices manufactured by different manufacturers to communicate with each other. Although the MIDI specification addresses several issues, individual manufacturers have had to define their own instrument patch definitions, resulting in a lack of numbering standardization among MIDI devices.

- General Authoring Guidelines for Device-Independent Files
- Prioritizing MIDI Data
- Standard MIDI Patch Assignments
- Standard MIDI Key Assignments

The MIDI 1.0 Detailed Specification doesn't define any standard patch assignments for synthesizers. Therefore, when you create a MIDI file, it won't be reproduced correctly unless it is played back on the same MIDI synthesizer setup used to create it. For example, if you create a piano concerto on one synthesizer and try to play it back on another, it might be played with a flute instead of a piano.

One solution to this problem is to map all the MIDI device patches from a common set of patch definitions. The Microsoft MIDI Mapper, included with Windows 3.1, maps one instrument patch number to another so that a nonstandard synthesizer knows which instrument is intended to be used, even though the original file uses standard patch numbers.

Succeeding topics offer the following aids to creating MIDI files usable for the different synthesizers that may exist in multimedia PCs:

- A list of general authoring guidelines
- How to prioritize your MIDI data
- The standard MIDI patch assignments
- The standard MIDI key assignments for percussion instruments

Using the MIDI Mapper, MIDI files authored to the guidelines set out in succeeding topics can be played on any multimedia PC with internal or external MIDI synthesizers.

General Authoring Guidelines for Device-Independent MIDI Files

Most sequencer programs available today include a channel mapping option that lets you direct that single channel to any of the other 15 channels available. This mapping capability lets you specify the exact channel on which you want to record.

Follow these guidelines to author device-independent MIDI files for Windows 3.1:

- Author for both base-level and extended synthesizer setups by adhering to the other guidelines of this topic.
- Use MIDI channels 13 through 16 for base-level synthesizer data (reserve channel 16 for key-based percussion instruments).
- Use MIDI channels 1 through 10 for extended synthesizer data (reserve channel 10 for key-based percussion instruments).
- To ensure a consistent sound on both extended and base-level synthesizers, duplicate the dominant melodies and harmonies in the first three channels for extended synthesizers and base-level synthesizers. You may need to reduce the polyphony for channels 13-15.
- Prioritize MIDI data by putting crucial data in the lower-numbered channels. See the topic, "Prioritize MIDI Data," later in this module.
- Limit the polyphony of nonpercussive channels to a total of 6 notes for base-level data and 16 notes for extended data.
- Limit the polyphony of percussive channels to a total of 3 notes for base-level data and 16 notes for extended data.
- Use the standard MIDI patch assignments and key assignments.
- Always send a program-change message to a channel to select a patch before sending other messages to that channel. For the two percussion channels (10 and 16), select program number 0.
- Always follow a MIDI program-change message with a MIDI main-volume-controller message (controller number 7) to set the relative volume of the patch.
- Use a value of 80 for the main volume controller for normal listening levels. For quieter or louder levels, you can use lower or higher values.

The following table summarizes the use of the 16 MIDI channels in a standard MIDI file authored for Windows 3.1.

Channels	Description	Polyphony
110	Extended melodic tracks	16 notes
10	Extended percussion track	16 notes
1112	Unused tracks	
1315	Base-level melodic tracks	6 notes
16	Base-level percussion track	3 notes

Prioritizing MIDI Data

Synthesizers don't always fall cleanly into the base-level and extended designations defined earlier. It's up to the user (or the manufacturer of the multimedia PC) to determine how to use synthesizers capable of more than the base-level requirements, but not fully meeting the extended requirements.

For this reason, it's important to prioritize the melodic data by putting the most critical data in lower-

numbered channels. For example, a user may have a synthesizer capable of playing six melodic instruments with 12-note polyphony. The user can use this device as an extended synthesizer by setting up the MIDI Mapper to play only the first six melodic channels and ignore any information on channels seven, eight, and nine.

Standard MIDI Patch Assignments

The standard MIDI patch assignments for authoring MIDI files for use with the Multimedia extensions are based on the MIDI Manufacturers Association (MMA) General MIDI Mode specification. The following list shows the standard MIDI patch assignments:

Piano	Chromatic percussion	Organ	Guitar
0 Acoustic Grand Piano	8 Celesta	16 Hammond Organ	24 Acoustic Guitar (nylon)
1 Bright Acoustic Piano	9 Glockenspiel	17 Percussive Organ	25 Acoustic Guitar (steel)
2 Electric Grand Piano	10 Music Box	18 Rock Organ	26 Electric Guitar (jazz)
3 Honky-Tonk Piano	11 Vibraphone	19 Church Organ	27 Electric Guitar (clean)
4 Rhodes Piano	12 Marimba	20 Reed Organ	28 Electric Guitar (muted)
5 Chorused Piano	13 Xylophone	21 Accordion	29 Overdriven Guitar
6 Harpsichord	14 Tubular Bells	22 Harmonica	30 Distortion Guitar
7 Clavinet	15 Dulcimer	23 Tango Accordion	31 Guitar Harmonics

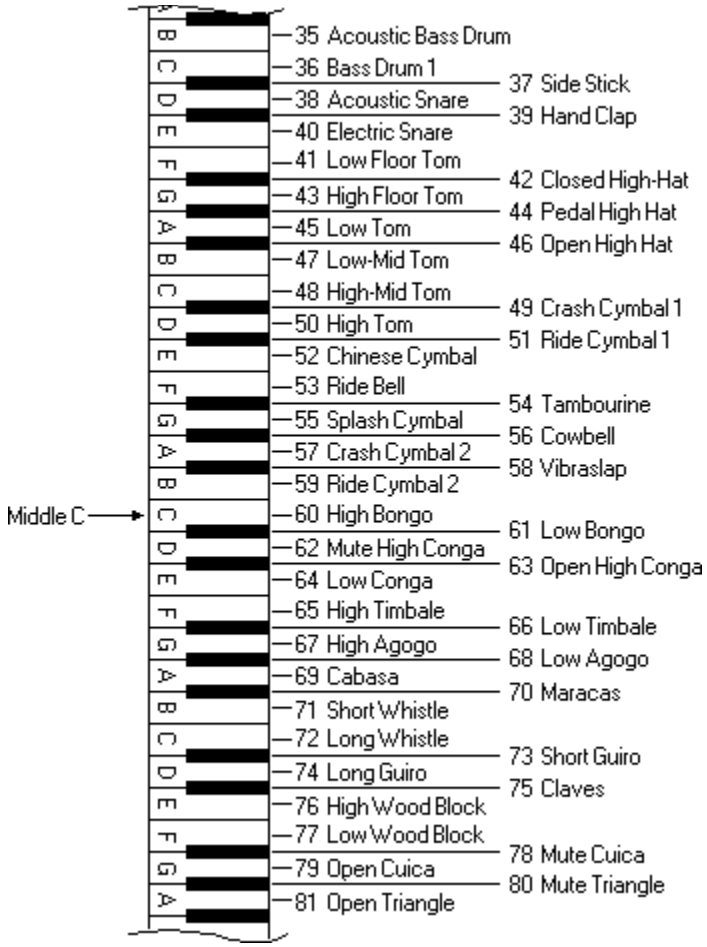
Bass	Strings	Ensemble	Brass
32 Acoustic Bass	40 Violin	48 String Ensemble 1	56 Trumpet
33 Electric Bass (finger)	41 Viola	49 String Ensemble 2	57 Trombone
34 Electric Bass (pick)	42 Cello	50 SynthStrings 1	58 Tuba
35 Fretless Bass	43 Contrabass	51 SynthStrings 2	59 Muted Trumpet
36 Slap Bass 1	44 Tremolo Strings	52 Choir Aahs	60 French Horn
37 Slap Bass 2	45 Pizzicato Strings	53 Voice Oohs	61 Brass Section
38 Synth Bass 1	46 Orchestral Harp	54 Synth Voice	62 Synth Brass 1
39 Synth Bass 2	47 Timpani	55 Orchestra Hit	63 Synth Brass 2

Reed	Pipe	Synth lead	Synth pad
64 Soprano Sax	72 Piccolo	80 Lead 1 (square)	88 Pad 1 (new age)
65 Alto Sax	73 Flute	81 Lead 2 (sawtooth)	89 Pad 2 (warm)
66 Tenor Sax	74 Recorder	82 Lead 3 (calliope lead)	90 Pad 3 (polysynth)
67 Baritone Sax	75 Pan Flute	83 Lead 4 (chiff lead)	91 Pad 4 (choir)
68 Oboe	76 Bottle Blow	84 Lead 5 (charang)	92 Pad 5 (bowed)
69 English Horn	77 Shakuhachi	85 Lead 6 (voice)	93 Pad 6 (metallic)
70 Bassoon	78 Whistle	86 Lead 7 (fifths)	94 Pad 7 (halo)
71 Clarinet	79 Ocarina	87 Lead 8 (bass+lead)	95 Pad 8 (sweep)

Synth effects	Ethnic	Percussive	Sound effects
96 FX 1 (rain)	104 Sitar	112 Tinkle Bell	120 Guitar Fret Noise
97 FX 2 (soundtrack)	105 Banjo	113 Agogo	121 Breath Noise
98 FX 3 (crystal)	106 Shamisen	114 Steel Drums	122 Seashore
99 FX 4 (atmosphere)	107 Koto	115 Woodblock	123 Bird Tweet
100 FX 5 (brightness)	108 Kalimba	116 Taiko Drum	124 Telephone Ring
101 FX 6 (goblins)	109 Bagpipe	117 Melodic Tom	125 Helicopter
102 FX 7 (echoes)	110 Fiddle	118 Synth Drum	126 Applause
103 FX 8 (sci-fi)	111 Shanai	119 Reverse Cymbal	127 Gunshot

Standard MIDI Key Assignments

The standard MIDI key assignments for percussion instruments are based on the General MIDI Mode specification. The following illustration shows the standard key assignments for MIDI files authored for Windows 3.1:


35 Acoustic Bass Drum
36 Bass Drum 1
37 Side Stick
38 Acoustic Snare
39 Hand Clap
40 Electric Snare
41 Low Floor Tom
42 Closed High-Hat
43 High Floor Tom
44 Pedal High Hat
45 Low Tom
46 Open High Hat
47 Low-Mid Tom
48 High-Mid Tom
49 Crash Cymbal 1
50 High Tom
51 Ride Cymbal 1
52 Chinese Cymbal
53 Ride Bell
54 Tambourine
55 Splash Cymbal
56 Cowbell
57 Crash Cymbal 2
58 Vibraslap
59 Ride Cymbal 2
Middle C
60 High Bongo
61 Low Bongo
62 Mute High Conga
63 Open High Conga
64 Low Conga
65 High Timbale
66 Low Timbale
67 High Agogo
68 Low Agogo
69 Cabasa
70 Maracas
71 Short Whistle
72 Long Whistle
73 Short Guiro
74 Long Guiro
75 Claves
76 High Wood Block
77 Low Wood Block
78 Mute Cuica
79 Open Cuica
80 Mute Triangle
81 Open Triangle

Text

Introduction

The one portion of multimedia that everyone feels familiar with is text. Text files form one of the largest segments of the multimedia developer's base of information. Many multimedia applications will be mainly text driven—developed by converting a book into an online multimedia application.

The target format for Windows 3.1 is either straight ASCII or Rich Text Format (RTF). For Multimedia Viewer, the target format is RTF. Microsoft Word for Windows™ easily converts most word processing formats to RTF. Whenever you convert text files, however, you invariably lose some original formatting. You still must add the proper formatting, indexing, and other referencing tags to make the text useful. This chapter provides an overview of the three main ways to get your text into a form compatible with Windows 3.1 and Viewer.

- Retyping it
- Scanning it in from print
- Converting it through the use of a computer program

With the proliferation of word processors, desktop publishing programs, and electronic typesetting systems, almost everything currently being printed also exists in one electronically readable format or another. If the issues associated with text preparation seem overwhelming, you have another alternative: pay someone else to do it. There are a number of data preparation houses that will take your text and return a finished product.

Note

Rich Text Format (RTF) is documented in the Word for Windows Application Note, "Rich Text Format Specifications," available from Microsoft. The subset of RTF recognized by Multimedia Viewer is documented in the *Multimedia Viewer Technical Reference* in this package.

Text

Text Preparation Hardware and Software

Text can come from a variety of different sources and in different formats, so it's difficult to propose one single hardware/software solution for text preparation. For basic text processing capability, you'll need:

- 80286-based or 80386-based DOS-compatible PC (if you plan to rekey the text, you might need several PCs), with VGA-quality display and 100-MB hard disk
- Microsoft Word for Windows to edit RTF text
- Laser printer to output pages for proofreading

Depending on your text sources and the preparation choices you make, you might need the following:

- OCR scanner and software
- Tools to convert text tagged with word processor or typesetting codes to RTF

Text

Retyping Text

Although typing is labor-intensive, it is often the most economical method to get large amounts of printed material into a computer. You can either have your staff rekey the text or you can contract with a service bureau. Typists enter the text directly into the system from the printed material.

There are a number of companies offering such a service. These companies generally claim 99.9% or higher accuracy through the use of double- or triple-key verification (also called double-blind or triple-blind typing). This means that they have two or three people type the same material, and then use a computer program to spot differences. The assumption is that several people won't make the same mistake at the same place in the file.

The cost of this service typically varies with the volume and complexity of the original material and the accuracy, turn-around speed, and extra services (such as format tagging) provided by the service company.

Some of the benefits of retyping text are:

- Rekeying printed documents is an established type of service, and you can reliably estimate the costs and time associated with such a project.
- The typists can include formatting and structural information into the text as they rekey it. This can reduce the time necessary to prepare the text for the retrieval software.

Some of the drawbacks are:

- Rekeying usually takes longer than scanning.
- A labor-intensive job such as this can become costly. (However, the cost of verifying scanned data is also high.)
- You must schedule time for proofreading and correction.

Text

Scanning Text

The concept of feeding printed material into a machine that recognizes each letter and feeds it into a text file sounds ideal. Fortunately, such technology exists and is called optical character recognition (OCR). Under the proper circumstances it can be a very efficient way to get text into a computer.

An OCR system consists of a scanner (quite possibly the same one used to scan images), a computer, and some software. The scanner converts a page of text into a bitmapped image, and the software analyzes the letter shapes and converts them into ASCII letters. The number of predefined typefaces is usually limited to less than a dozen, although many systems have a learning facility to include new characters and typefaces.

The results you get from scanning can vary greatly. For more information, see Getting Better Results When Scanning.

You scan every page and then you run various utility programs (such as a spelling checker) to detect misreads and other scanner errors. For the final step, print and proofread the text.

Some of the benefits of using OCR are:

- Scanning requires little up-front labor.
- An OCR scanner can quickly convert large amounts of printed information into electronic files (less than a minute per page).
- Scanning usually costs less than re-keying.

Some of the drawbacks of OCR are:

- Some scanners can read only a limited set of typefaces. Other scanners read more typefaces, but you first have to train them by running samples through the scanner and then calibrating its interpretation of the test.
- Assuming an accuracy rate of 99%, scanned text contains an average of one error for every two lines of text. This error rate can mean hundreds of thousands of errors for long texts. You must schedule time for editing and proofreading.
- You can lose special symbols (such as Greek or other foreign characters) and complex formatting (such as tables, mathematical formulas, or special fonts).

Text

Getting Better Results When Scanning

Here are four factors that control the results you get with OCR:

- Quality of the original text
- Type of scanner
- Speed (power) of the computer
- Quality of the software

Start with High-Quality Printed Material

The process of optical character recognition is much like a person reading. Like a person's eye, the scanner analyzes light reflected from a page to create a pictorial representation of what is black (the ink) and what is not black (the paper). This picture of the page is stored in the computer where the OCR software tries to chop the black parts up into individual letters and then guess what each one is.

Generally anything difficult for a person to read will be impossible for an OCR system to convert. This includes such things as smudged text, small type, strange fonts, characters that are too close together, and typewritten characters created with an old ribbon or dirty keys.

The bottom line to OCR efficiency: Always start with high-quality printed or typed material.

Choose an Appropriate Scanner

Given good clean text, the next critical element in the system is the resolution of the scanner. Typical scanner resolutions range from 75 to 450 dots per inch (DPI). The higher the resolution of the scanner, the higher the likelihood of accurate recognition by the software. Although some companies claim to be able to accurately recognize text at 200 DPI, 300 DPI is probably the lowest practical resolution.

Another factor that influences the suitability of a scanner for OCR is its method of feeding. The two standard methods are flatbed and roller-fed:

- Flatbed scanners are like photocopiers in that the material to be scanned is placed on a glass plate, covered by a lid, and then passed over by a light.
- Roller-fed scanners are like a typical FAX machine, in that text is scanned after being fed in through rollers.

Flatbed scanners are well suited to bound, oversized, or especially small pages. Roller-fed scanners are good for bulk scanning of material with a consistent format. A flatbed scanner with an optional document feeder offers the best of both worlds.

Use a Fast Computer

The power of the computer used in an OCR system doesn't affect the accuracy of scanning. Nevertheless, we recommend the computer have at least an 80386 processor running at 25 mHz. Also, since most OCR programs require large amounts of memory, having 4 MB of RAM or more will enhance performance.

Select Fast, Accurate OCR Software

There are dozens of OCR programs on the market. Most of these are simply software programs that you load into a computer and run, though some high-end programs work with a board that plugs into the computer. These hardware and software combinations are usually faster, more accurate, and more expensive.

There are a lot of options available when buying OCR programs. Some of the more interesting ones can do the following things:

- Read both monospaced and proportionally spaced fonts
- Read dot-matrix output
- Learn new fonts
- Mix text and graphics
- Define frames of text to read
- Retain character formatting attributes
- Retain columns (tables)
- Save in various word-processing formats
- Run a spelling checker on scanned files

Be aware, however, that character recognition systems rarely achieve more than 95% accuracy on anything but the cleanest of text. Even at 99% accuracy, there could be 20 mistakes on a typical 2,000-character page. So, budget time for running a spelling checker and proofreading.

There are almost an infinite number of combinations of specific scanners, computers, and software packages. If you have printed pages numbering in the hundreds, OCR may work for you. If you have massive amounts of printed text, you should consider hiring a data-entry service to have it rekeyed.

Converting Text

If your data is in a standard word-processing format that Word for Windows version 2.0 or later can accept and convert to RTF, then you might be able to arrive at usable RTF files in that single step. The usefulness of the converted files might still be limited by imperfections in the conversion and the fact that Viewer does not accept all Word formatting attributes.

If your data is in a format that Word for Windows cannot accept, you might be able to use an off-the-shelf program to convert your files to another format that Word can accept and convert to RTF. (Beware of using anything but Microsoft Word for Windows version 2.0 to convert to RTF: Other varieties of RTF may use coding that will cause errors in Word and Viewer.) As with any automatic conversion, you'll be fortunate to end up with data that has the same attributes it started withnot necessarily the attributes you want for your new title.

If the formatting in your files can't be automatically converted by Word or other off-the-shelf converters, try to output the files as ASCII text. If you can't do that yourself, a conversion bureau probably can do it for you. These ASCII files can then be routed through a custom conversion routine that formats them properly, based on remnants of existing format codes or patterns in the text itself. Or you can open them in Word for Windows version 2.0, reformat them compatibly with Viewer, and save them as RTF files.

Custom conversion programs depend on recognizing patterns in the source and using a look-up table to trigger an appropriate response, such as deleting existing coding and putting new coding in. To be compatible with Word for Windows and Viewer, RTF coding must conform to the requirements of both the Word for Windows application note, "Rich Text Format Specifications," and the *Multimedia Viewer Technical Reference.*

The combined macro and search-and-replace capabilities of Word are a powerful off-the-shelf tool for reformatting after automatic conversion or for pattern conversion from ASCII files, but Word is not as fast at this as a true conversion program.

Develop any custom routine after analyzing the source and destination files as set out in subsequent topics of this module:

- Analyzing Destination Files for Custom Text Conversions
- Analyzing Source Files for Custom Text Conversions
- Tracking Converted Text Files
- Proofing the Correction of Converted Text Files

To reduce conversion hassles in the future, consider using Word for Windows RTF, SGML (Standard Generalized Markup Language), or another generic file and markup format for all new projects, whether in print or multimedia.

Analyzing Destination Files for Custom Text Conversion

You should look at what you want to produce before you start to convert the text. There are a variety of elements that may require tagging in the text portion of a multimedia title:

- Character attributes**.** These are the codes that indicate bold or italic type styles, character fonts, color, inverse video, etc.
- Hierarchy**.** The document hierarchy is its basic structure. This is usually expressed in book terms, and includes such hierarchical elements as title; chapter heads; and first-, second- and third-level heads.
- Links**.** These are the hypermedia elements that you click to initiate some action, such as jumping to another location, displaying a picture, or playing audio. Links are the most difficult element to automatically add to a file.

Define these and other elements of your target text so that you will know what to change existing tags to when completing the tag list of your conversion setup.

Analyzing Source Files for Custom Text Conversion

Once you know where you want to end up, look at the source file to find out what format you are starting with. The worst, and fortunately least likely, case would be a file created by some obscure word processor that stored text and formatting separately. More likely, you will have a file created by a typesetting system or a desktop publishing program that creates files in plain ASCII with embedded tags.

Ideally, you will have complete documentation on the system used, with a list of all tags and their precise meaning. If you don't have this information, extract a list of the tags from the source file, and then figure out the meaning of each by comparing its use in the source file to its effect in the printed document.

Once familiar with all the tags used in your source file, you can indicate on the tag list of your custom conversion program which to convert and which to delete. Your analysis should let you be able to directly convert character attributes and hierarchical elements. However, cross references, footnotes, and various kinds of other links will be more difficult.

Note

The most difficult type of tagging to convert is that of cross-references and other links because these often aren't tagged in the source file. The more obvious ones, such as see Chapter 6, or see Section 3.7.2, or as shown in Figure 5-2, can probably be done, because they refer to an element that should already be tagged. References to something earlier in this chapter or shown previously are more difficult, and might require editing by hand.

Tracking Converted Text Files

One of your most important tasks in converting text files is to track the flow of documents through the data-preparation process. A large job, such as a 20- to 30-volume encyclopedia, might consist of 20 MB of data broken into thousands of individual files. You may have to pass each file through a dozen or more conversion stages.

There is no need to save every stage forever—you could have 100,000 files—but you shouldn't start deleting them until certain that the last stage is error free. If an error does pop up, you'll want to be able to retrace the path and spot the cause.

Proofing and Correction of Converted Text Files

Proofing is a tedious but essential step of text conversion. Two types of tools that take some of the pain out of the process are syntax checkers and text editors that hide the tags.

Syntax checkers examine a file for such things as begin-end tag sets that aren't balanced and structural or nesting tags that aren't in an acceptable order. Most data-preparation houses can write such programs for specific jobs.

A text editor capable of implementing the tags—hiding them from view and performing their function, such as bolding a string of text—makes it far easier to visually proof a document than if it is cluttered with tags. The availability of this feature alone is a compelling reason for converting source files to RTF using Microsoft Word for Windows. They can then be loaded into Microsoft Word for Windows for proofing and additional editing or tagging. The resulting file can be saved in RTF format, for input into the next stage of the document processing cycle.

You may discover that existing electronic files don't match the current printed material you want incorporated into the multimedia title. This can happen because corrections are typically made manually near print time, and sometimes those changes don't get made in the source text files as well. If you find discrepancies, you'll need to add another step to collect all the changes and incorporate them into the electronic files.

CD-ROM

Introduction

You can often trace an industry to a single invention. Publishing started with the printing press; recording started with the phonograph; motion pictures began with the movie camera. The heart of the multimedia PC is its CD-ROM drive. Every multimedia PC has a CD-ROM drive, which enables it to deliver large-scale, content-rich titles quite easily.

CD-ROM stands for compact disc read-only memory. The information used by a multimedia title is stored on a compact disc identical in size and appearance to an audio CD. You can only read data from a CD-ROM disc; you can't write information to it. The information contained on a CD-ROM is unalterably defined as the disc is manufactured.

This module discusses the following topics:

- CD-ROM technology
- How CD-ROM technology should factor into title design
- The process of publishing a title on a CD-ROM

Computers without a CD-ROM drive—even though they may provide marvelous technical capabilities—lack any way to access large amounts of data other than what can be loaded into their hard drives a diskette at a time. They are limited by the size of their hard drives, or to the expensive option of removable magnetic media. CD-ROM is cheap, it holds lots of information, and it is easy to distribute. CD-ROM makes the multimedia PC an excellent platform for the delivery of multimedia titles.

This discussion is meant to provide an overview. For more detailed information, read through the CD-ROM series of books published by Microsoft Press.

CD-ROM

What is CD-ROM?

CD-ROM uses the same basic technology as the audio CD with which you're already familiar. An audio CD contains music translated from analog into digital information and pressed onto a plastic disc as a sequence of pits and level areas equivalent to the ones and zeros that compose digital information. A laser beam from the CD player scans the CD surface and translates this information into digital data. This data is converted back to an analog waveform and then amplified. Eventually, beautiful music comes out your speakers.

CD-ROM is based on the same principle. But along with audio, it can also hold other types of digital information, such as text, graphics, and animation.

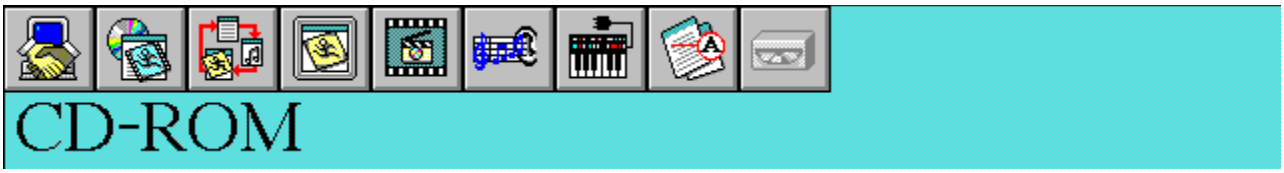
CD-ROM

Designing for CD-ROM

Once you decide to build a CD-ROMbased title, you need to consider how certain capabilities of CD-ROM affect your title's design. For example, because a CD-ROM is read-only, the user of a title will never be able to write anything directly to the disc. If your application requires information from the user be stored, you'll have to establish a file or files on the hard disk for this purpose.

The following topics discuss some other factors you should think about during design:

- Naming and Locating CD-ROM Data Files
- Storage Capacity of CD-ROM Discs
- Data-Transfer Rate
- Seek Time



Naming and Locating CD-ROM Data Files

The CD-ROM standards prohibit the use of punctuation (such as periods or hyphens) or lowercase letters as either directory names or filenames. The only characters allowed for CD-ROM are A-Z, 0-9, and the underscore (_). For example, the filenames FILEONE.TXT and FILE_ONE.TXT are OK, but FILE-ONE.TXT and FILE-1.TXT won't work.

Also, when laying out the file and directory structure of your title on the disc, make sure to limit the number of files in a directory. If you have a large number of files in a directory, this can significantly increase the time necessary to open a file.

Storage Capacity of CD-ROM Discs

A single CD-ROM disc can hold up to 680 MB of information. You could conceivably store 150,000 printed pages or about 250 large books on one disc. This amount of storage seems almost limitless compared to the 40-100 MB hard drives currently popular.

This isn't quite true. Even though text requires relatively minimal storage, a full-featured multimedia title probably includes not just text but animations, video sequences, audio sequences, and full-color images—all of which require substantial storage.

So don't fool yourself in thinking that CD-ROM offers a panacea to all storage restrictions. If you plan for your title to be more than just text, you better also plan how to best use the space on your disc. Images, audio, video, and animations will quickly take over the space available.

CD-ROM

Data-Transfer Rate

A key issue to always consider when designing a title is the rate at which data transfers from the CD-ROM to your computer. The multimedia PC standard establishes a minimum transfer rate of 150K per second. That doesn't mean much until you consider the numbers involved in multimedia, and compare CD-ROM to hard-drive performance.

An uncompressed 256-color, full-screen image (640 by 480 pixels) is about 300K in size. Transferring this image from the CD-ROM to the computer at 150K per second takes about 2 seconds—and this doesn't include any seek time or processing time by Windows to display the image. Compare that with a fast hard drive, which might easily transfer the same information in a few hundredths of a second.

Compression and read-ahead techniques can reduce the time involved, but the issue remains: You have to factor transfer rate into your product design. You might decide to use smaller images with fewer colors. Or you could transfer large images or audio while text is being displayed for the user to read. There are many different ways to work around this issue, but you need to consider them during design.

Seek Time

Another issue associated with CD-ROM drives is the time it takes to find what you want to read from the disc. This is known as *seek time*. The multimedia PC standard states that the average seek time must be 1 second or less. Remember, this is time added to the time required to transfer the data. Your objective when designing a title, regardless of the authoring method used, is to reduce the number of seeks the drive has to make to access your data.

Viewer reduces the number of seeks by loading a directory of multimedia elements as the title is opened, so any multimedia file in the title can be found without referring to the standard file directory of the CD-ROM. Viewer also has an option that will arrange data on the CD-ROM for faster and more efficient reading.

Putting a Title on CD-ROM

You have gathered your data—text, images, audio, animations, and so on—and built your multimedia title. Now you want to put it on a CD-ROM for distribution. The process of turning a title and its associated files into a CD-ROM disc loosely divides into the stages described in the following topics:

- Premastering
- Final Testing
- Mastering and Replication

These stages often merge and overlap. Premastering, testing, mastering, and low-quantity replication are activities you can perform in-house if you want to invest the time and effort. Large-scale replication, however, which requires an enormous capital investment, will probably be done by a company that specializes in this service, such as 3M.

Premastering

Premastering is the stage of production in which the data is organized as it will be on the final CD-ROM disc. The primary activity is building the logical structure that allows your application to locate and retrieve data from the disc. Premastering involves the following steps:

- Physically interleave audio and images as required by your application.
- Build the logical structure required by the file system/operating system.
- Build the final disc image.
- Block the data to mastering facility requirements.
- Store the data on a medium acceptable to the mastering facility.

Note

Windows 3.1 doesn't currently directly support interleaving data (such as audio and images) on a disc. You can, however, use interleaving if your title requires it for performance reasons and can handle the de-interleaving. If interleaving is required, it is important that the facility premastering your disc understands and can accommodate your title's interleave format.

The equipment required to do your own CD-ROM premastering can cost anywhere from $4,000 to $10,000. Companies such as 3M sell premastering systems to produce an exact disc image of your data. This image can be stored on optical disc, DAT, or 9-track tape, and sent off to a mastering plant for final production.

If you don't want to invest in the equipment, many companies are available to do the work for you. Contact them directly for information on the range of services they offer, the cost, and the preferred transfer medium—usually 9-track tape, DAT, or some form of optical media such as WORM (write once, read many).

Final Testing

Testing is an ongoing process. By the time you reach the premastering stage you should be positive that your text is flawless, the images and sounds look and sound perfect, and the overall application is just as you want it. Performance testing is particularly important in multimedia applications, especially where you load images and sounds—perhaps even with some degree of synchronization.

There are two main ways to test the performance of your application: You can press a disc and run it, or you can run the application in a simulated CD-ROM environment. Both methods have their advantages. Some premastering systems offer you a choice. For a nominal fee they will create a *one-off* disc for you to test until you are totally satisfied. If you have extensive testing to do, this is a good approach as it won't tie up a lot of expensive equipment at a high hourly rate.

Premastering systems can often simulate a CD-ROM environment by storing the data on a large hard disk that has had its access time and transfer rate reconfigured to simulate that of a CD-ROM. The advantage of simulation is that you can usually do some fine-tuning. If you find a problem area, you can make corrections and repeat the test.

Mastering and Replication

Mastering and replication is a mechanical process, and any established facility you deal with has probably done it thousands of times. Very few errors creep in at this point. If your disc doesn't work, it is likely because there was something wrong with the data or format sent in. The mastering steps include:

- Verifying that the tape is readable
- Adding synchronization data, header data, error detection codes (EDC), and error correction codes (ECC)
- Writing data to magnetic disc
- Creating a glass master
- Creating a metal stamper
- Replicating the discs

You don't need to understand all the details of this process. You do, however, need to know exactly what the mastering facility expects to receive. Work with their representatives to ensure you provide the data in the proper format.

The cost of mastering and replication can also include the printing of a simple label on the disc, and the insertion of the disc and printed material into a jewel box. You must supply the printed material and the film for the label, usually several days before supplying the data to be mastered.