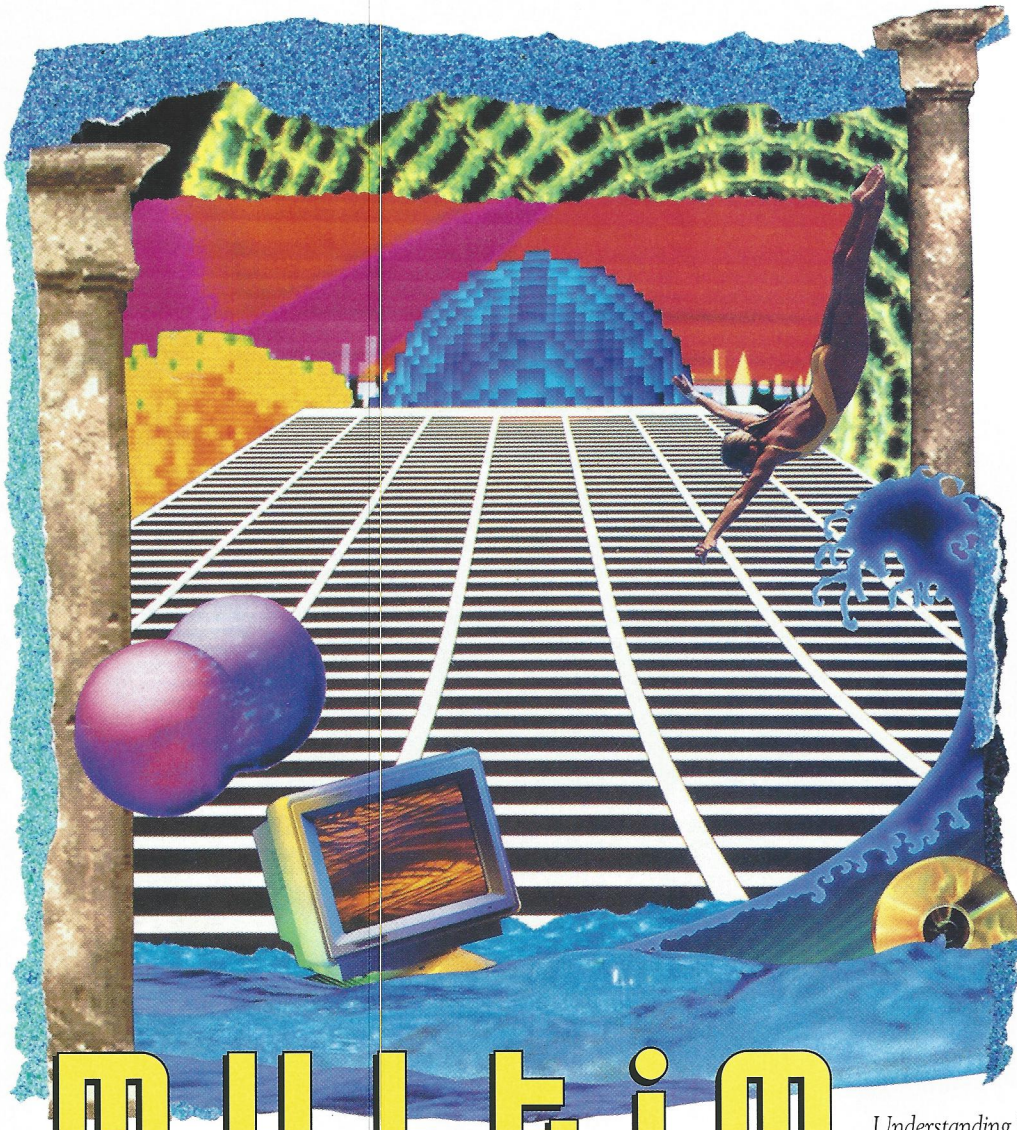

Carol Norby

Multimedia

It's Not Just for Video Games Anymore

BY Laura Chappell, Roger Spicer, and Dan E. Hakes

Imagine...

that learning about new technology could be as entertaining as your favorite television program and as interactive as traditional classroom education. Suppose, for example, you wanted to investigate FDDI-based networking. You could pop a CD-ROM into your CD-ROM drive and launch a program that explains FDDI. It might look something like . . .

At first, triangles spin independently toward the center of the screen as Ravel's Bolero plays. The triangles smash together in the center of your monitor as the music reaches a crescendo, sprinkling splinters of refracted light into the black background until, finally, a single triangle remains. The gold, three-dimensional words *Understanding FDDI* scroll across the screen from right to left. A button labeled "begin" appears in the lower right corner of the screen.

You click on the button, and the screen fades to black. A rectangle opens up to reveal a man with a big smile. "Hello," he says. "On the left of your screen, you see a fiber optic cable." As he speaks, a three-dimensional cable appears. It bends and rotates, allowing you to examine the cable up close, in detail.

"Throughout this training session," your narrator continues, "you will view video clips of fiber optic cable being installed and will be able to manipulate the settings on an FDDI adapter that you install in a server and workstation. If you ever need assistance, please click on the Help button, and I'll be happy to provide you with additional information."

Sound like something out of a Star Trek episode? The capabilities of the PC and the multimedia application described are, in fact, a reality. In this, the first of a two-part series of articles, we will explore multimedia—what it is, how it can improve applications, what technology is available now, and what hardware and

software are required to create multimedia presentations. In Part 2 of the series, we will explain how to implement multimedia on your network.

The Multifacets of Multimedia

Multimedia is a generic term used to describe the collective technology that allows computers to convey information and users to request, collect, and manipulate that information in media other than text. Some of these media are graphics, graphical animation, audio, and video.

The Macintosh and MS Windows have built-in support for multimedia hardware and applications.

Multimedia was initially popularized for PCs and Macintoshes in games (remember the original Flight Simulator?) and educational applications. Recently, however, multimedia has experienced a rapid increase in popularity for all types of applications. This rise in popularity is due primarily to the advanced capabilities of today's operating systems and the rapidly falling cost of the required hardware.

Multimedia is typically implemented within a graphical user interface (GUI) that can be either passive, where the user is an observer, or interactive, where the user's responses determine the branching of a multimedia presentation and thus the flow of information.

Passive implementations are used in kiosk applications that demonstrate a company's product features or benefits in the form of a slide show or movie. The interactive applications typically require you to input some information about yourself (name, buying authority, and so on) and enable you to move about to get just the information that applies to you.

Passive presentations are easy to create, and development applications abound. Interactive applications, however, are typically more difficult to create since you must define the types of responses allowed and make decisions on the next action based on user input.

Multimedia Enters the Business World

Although its popularity is increasing, multimedia is still used primarily in the education and game environment. A number of multimedia reference books and courses are being distributed on CD-ROMs. Games such as the 7th Guest and Critical Path are created using sound, graphics, video, and animation. These games use some of the most interesting GUIs available today.

Multimedia can go farther than education and games, however. Companies are beginning to use multimedia for sales presentations, on-the-job performance support systems, and performance evaluations. For example, one Fortune 100 company has installed a multimedia application in its customer support division. The application automatically launches when a support representative answers a phone call and guides the representative through name verification, entering the customer's account number, and other required procedures. The representative advances through the application based on the type of inquiry. If the representative is unaware of the options available for the client, he or she can view a short (15-30 second), animated presentation of the options.

American Airlines uses a multimedia application to train and test travel agents. The agent views a video sequence of a customer who wants advice on where to go on vacation. The agent selects questions to ask the customer and watches a video clip of the customer's response. Based on the interaction, the agent selects a vacation spot and presents it to the customer.

American Airlines also has a unique way of providing feedback to the agent. The customer calls to let the agent know what he or she thought of the vacation. If the agent selected a beach vacation for an elderly couple that gets sunburned easily, the irate couple calls the agent to demand their money back. Satisfied customers flash a relaxed, glowing smile and thank the agent for the excellent advice.

Microsoft Windows 3.1 and the Macintosh operating systems both support GUIs and have the built-in capability to support multimedia hardware and applications. These capabilities have created an environment where multimedia applications are easier to create and are based on a standard set of application programming interfaces (APIs) and hardware. (See "Multimedia PC Standards," pp. 18-19.) The MS Windows environment has not only resulted in new multimedia applications but has eased the integration of multimedia into common business applications.

Another factor in the expanding use of multimedia is the rapid advancement of multimedia technology—especially in the areas of CD-ROM, audio, and video—and the decreasing costs of the optional multimedia hardware and software. Many PC vendors are now shipping PCs that are preconfigured with multimedia hardware and software and comply with the Multimedia PC level 1 or level 2 standard.

Enhance Your Business with Multimedia

Using multimedia, developers and presenters can provide a more accurate, interesting view of a subject. For example, if we wanted to explain how to install and configure a network interface board, we could show a graphic of the board and, using three-dimensional animation, zoom in on the board to see the jumper settings. We could also bring up a video of someone installing a board into a file server and explain the steps necessary to check for conflicts between the board and other devices in the server.

Not only is this presentation more valuable to users—giving them the benefits of a hands-on class—but the presentation is much more interesting than reading a six-page document describing the process.

Now that we've perused the uses and benefits of multimedia, let's examine the exciting part of multimedia applications—the elements. There are four primary elements of a multimedia product:

- The GUI
- Two-dimensional or three-dimensional animation
- Audio
- Video

Let's Get Graphic

A multimedia product's GUI defines the overall look and feel of the product. The GUI is made up of several elements that dictate the product's "look," as well as the navigational system (buttons or tabs). For example, if we were hired to create an interactive multimedia product that focuses on network design and testing, we may use a look similar to that shown in Figure 1.

The fact that the product may be distributed worldwide influenced the decision to use icons for all navigation buttons.

An impressive, colorful graphical interface can, however, become a hindrance if it requires you to purchase new hardware to display it properly. For example, if you are using a multimedia presentation to teach network users how to use the new E-mail and voice mail systems, you may want to use a 16-color application if some users only have 16-color display systems.

As we mentioned, the sudden explosion in multimedia titles is caused partly by dramatic changes in the market. For example, high-resolution monitors have dropped in price, enabling you to purchase a 1024 x 768 resolution monitor for slightly more than U.S. $200. High-performance video boards have also dropped in price dramatically over the last several years. Right now you can purchase an ATI graphics board that supports 16.7 million colors and a resolution of up to 1280 x 1024 for well under U.S. $200. Interestingly, many users run their MS Windows workstations in 16-color mode although their monitor and graphic board can support more colors (typically, at least 256 colors). Contact your board manufacturer to determine if it has a 256-color graphics driver for your board.

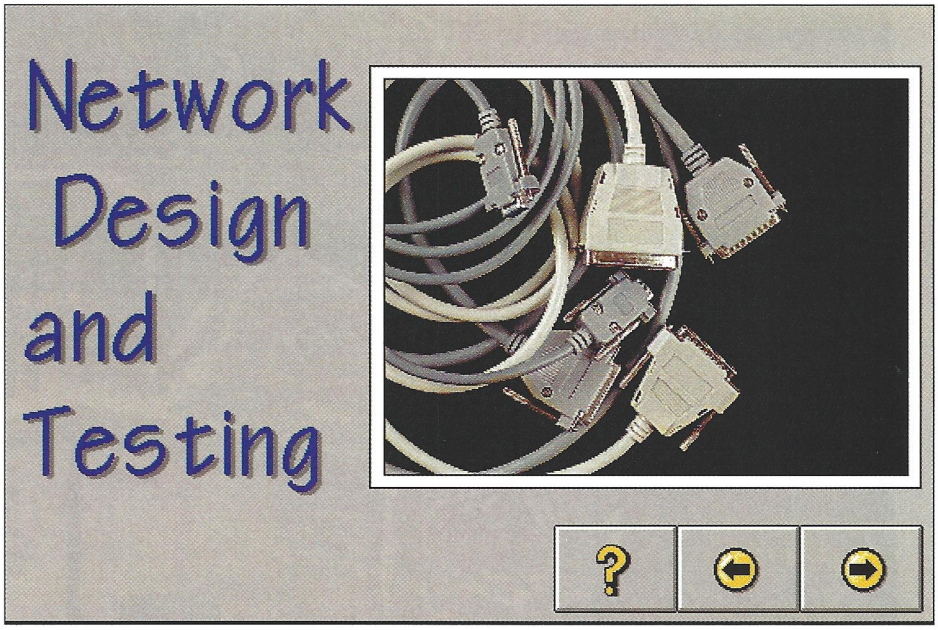

Figure 1: Today's GUI software uses symbols and pictures, which transcend language barriers.

The Format of Graphics Files

When you purchase or create a multimedia product using images, you can use several graphical formats. Typically, the format selected is based on the ability to compress, convert, and edit the images.

Two types of images are used on computers: raster and vector. One of the main differences between the two file types is the ability to change the size of the image. Because a raster image is composed of pixels, it does not size well. As you increase the size of the image, a single pixel expands to a block, resulting in rough, jagged edges. Raster images are created and edited with paint programs such as PC Paintbrush. Raster images are usually larger than vector images, but are easier to compress.

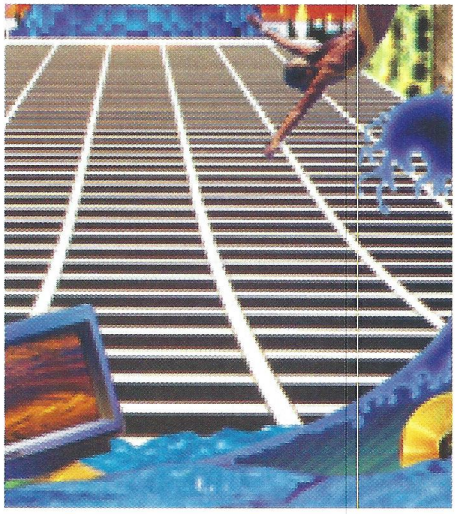

Figure 2: If you save this image in different graphic formats, the size of the various files will differ significantly.

Vector images, on the other hand, can be enlarged and maintain a smooth look because they are not pixel based. Vector images are composed of instructions to reconstruct the image. For example, a circle can be described in terms of its center, radius, and the width of the line used to draw the circle. Vector images are usually smaller than raster images and more complex.

The most common graphic formats include PCX, BMP, EPS, GIF, RLE, TGA, and TIFF. Let's take a look at these formats and see how they affect file sizes for the graphic shown in Figure 2. (For more information about these file types, see "Jargon, Acronyms, and Other Interesting Terms," pp. 23-24.)

Format Type	Size (in bytes)
PCX	11,122
BMP	34,274
EPS	36,280
GIF	3,353
RLE	13,998
TGA	12,271
TIFF	36,162

GIF format graphics are significantly smaller than the other formats. The GIF format is a compressed format that was developed for use on CompuServe, an electronic information service. Because GIF is already compressed, running a compression utility such as PKZIP will not reduce the file size significantly. BMP files, on the other hand, compress well.

If you are creating a multimedia presentation for distribution, keep disk space limitations in mind. If, however, you have plenty of space available, you may want to look at adding two-dimensional or three-dimensional animation to your product.

Animated Images

Deciding between two- or three-dimensional images depends on your needs and your budget. In many cases, two-dimensional images and animation can adequately portray an idea. For example, if you want to show how a NetWare client sends requests to a server, you could create a two-dimensional graphic that shows a packet moving from the client station to the server, passing up through the server protocol stack and being processed by the operating system. Two-dimensional graphics can be created by most authoring tools and do not require any special steps to run the animation.

For projects that require strong visual impact, three-dimensional images or animation are often the best solution. A three-dimensional graphic can rotate, spin,

Record Speed (Sample Rate)	Resolution	Mode	File size for each minute of sound
11KHz	8 bit	mono	661KB
11KHz	8 bit	stereo	1.3MB
11KHz	16 bit	mono	1.3MB
11KHz	16 bit	stereo	2.6MB
22KHz	8 bit	mono	1.3MB
22KHz	8 bit	stereo	2.6MB
22KHz	16 bit	mono	2.6MB
22KHz	16 bit	stereo	5.3MB
44KHz	8 bit	mono	2.6MB
44KHz	8 bit	stereo	5.3MB
44KHz	16 bit	mono	5.3MB
44KHz	16 bit	stereo	10.5MB

Figure 3: *When sounds are converted into a digital format, the quality of the recording (sampling rate, resolution, and mode) affects the size of the file.*

rock, and so on, and display a more believable image with height, width, and depth.

Although three-dimensional graphics provide a more sophisticated look, in an MS Windows environment, you will need additional software to animate a three-dimensional image. If you install a three-dimensional animation product on an MS Windows station, you must also install a three-dimensional player driver, such as the Autodesk Animator Player. Typically, this player driver is included with the multimedia package and is automatically installed for you. The Macintosh platform also has several three-dimensional graphics and animation packages.

The cost of producing three-dimensional graphics and the size of files inhibit their use in most multimedia productions. For example, it could cost from U.S. $2,000 to $10,000 to have a company logo "lofted" into a three-dimensional image and spun around 360 degrees.

The market for creating three-dimensional animation on the PC has become very competitive. To create animation, you must purchase an animating software package or a complete hardware-software animation package. The Amiga in combination with New Tek's Video Toaster has gained a large and loyal following as a hardware-software animation package. One of the best Macintosh packages (feature rich and easy to use) is Strata Studio Pro by Strata, Inc. These animation packages are used to build and render three-dimensional artwork.

Three-dimensional animation rendering packages range in price and performance. One sophisticated and versatile package is 3D Studio by Autodesk Animator. When shopping for an animation package, keep in mind that price is only one consideration. You must invest significant time and energy into creating three-dimensional animation. First, you must learn how to use the product, and then the rendering time for a fairly complex animation can be as long as 16 hours. (For an explanation of *rendering*, see the glossary on p. 24.)

File Formats for Animation. Flic file formats—produced by 3D Studio, Autodesk Animator Pro, and Autodesk Animator—have become the standard file format used for 8-bit PC animation. Flics created by applications such as Autodesk Animator are limited to a resolution of 320 x 200 and have the .FLI extension. 3D Studio flics, however, are resolution-independent and use the .FLC extension.

The Sound and the Fury

Many users will first enjoy the benefits of multimedia through the sounds coming from their PC or Macintosh. There are several reasons why sound will often be implemented first:

- Digital recording and playback are well-understood technologies (due, in part, to the popularity of audio CDs).
- The storage requirements for sound files are a fraction of those required for video.
- Enabling a PC for sound playback or recording can be simple and inexpensive.
- Sound can have many business benefits including increased productivity, improved communication, and increased employee satisfaction.

Imagine this simple scenario: while using a word processor, you decide to add a table to illustrate an important point. You select Table from the menu bar and say the word *help*. An arrow appears on the screen, and as it directs your attention to certain options, a voice guides you through all the steps necessary to create your custom table.

After completing your document, you decide that one of the cells of your table needs some explanation. You drag the speaker icon from the menu bar to the cell and click on the Start Recording button that appears when you release the icon. After recording your explanation, you again click on the button (which now says Stop Recording), save your document, and send the file as E-mail to a coworker.

Applications like this are starting to appear, and the productivity savings are obvious. Already, sound board manufacturers are bundling sound-enabled applications and utilities that help users perform many common tasks. The following sound board features can increase productivity:

- You can execute MS Windows functions and launch applications with spoken commands.
- You can proofread documents and spreadsheets with text-to-speech translation.
- You can insert sound files into any MS Windows document using Object Linking and Embedding (OLE) technology.
- You can use audible reminders of appointments or scheduled events.

If the technology is available to automate tasks and increase communication, why isn't it on more desktops? Only recently have prices decreased and ease-of-use increased to the point where the investment in hardware, software, and support can be justified. Also, few people know enough about the technology to feel comfortable making "sound" implementation decisions.

Sound Facts for Sound Decisions

There are two major techniques for reproducing sound on your PC—waveform

and Musical Instrument Digital Interface (MIDI).

Waveform or wave files are digitally sampled and encoded analog sounds. Analog sounds are the sounds we are familiar with in everyday life. These sounds can have an infinite variety of volume, tone, and other characteristics.

When these sounds are converted into a digital format, the quality of the sound depends on how often the sound is sampled. Common rates are (approximately) 11,000, 22,000, and 44,000 times per second. The sound quality is also dependent on how many bits (the resolution) are used to describe each sample. Common resolutions are 8 and 16 bits per sample.

If you need stereo, you will require twice the storage and playback needed for mono. The higher the sampling rate and the higher the resolution, the better the quality of sound will be. If you are using voice annotation or if you are using a few sound effects to "jazz up" a presentation, mono, 11KHz, and 8 bits may be good enough. If your subject is music, however, you may want CD-quality— 44KHz, 16 bit, stereo.

Quality costs disk space. Figure 3 shows how the size of files increase as you improve the quality of the recording. Experiment with different settings to find the quality that suits your application.

An analog-to-digital converter (ADC) samples the sound several thousand times a second and records information about each sample in a digital format. For playback of waveform files, a digital-to-analog converter (DAC) reproduces the analog signal from the digital information. Waveform files will usually have the extension .WAV, although some vendors may use other extensions (.VOC, .SND, and .MOD are the most common).

Unlike waveform files that contain information to reproduce a specific sound, MIDI files contain instructions on how to create a sound. MIDI is commonly used by musicians to specify how music should sound. For example, they can specify what notes are played, for how long, and certain sound qualities.

A MIDI instrument can interpret the instructions and play the music. Until recently, MIDI was an expensive add-on, but now it is common on standard sound boards. Now that MIDI is part of the Multimedia PC Level 2 (MPC2) specification and is often included in low-priced boards, we may see greater use of MIDI by nonmusicians. (See "Multimedia PC Standards," pp. 18-19.) Today, however, MS Windows multimedia is mainly the domain of wave audio.

You have many options when adding sound capabilities to your PC. The safest path in selecting hardware is to buy an audio board that is MPC2 compliant. "Multimedia PC Level 2 Standards for Audio Boards" summarizes key MPC2 requirements for audio boards and explains why they may or may not be important to your implementation. (See p. 16.)

Sound Recommendations

If following the MPC2 specifications was all that was necessary to ensure success in your multimedia endeavors, life would be easy. You should, however, keep the following additional guidelines in mind:

Sound boards are often used as the CD-ROM interface board as well. You can ensure compatibility with additional hardware and software by purchasing a multimedia bundle including an audio board, CD-ROM, and software. You can increase your future options by selecting an

Multimedia PC Level 2 Standards for Audio Boards

MPC2 Requirements	Real-life Application
16-bit recording and playback capability	Analog sounds are sampled (see Figure 3 on p. 14) and recorded in digital format. Each sample will be described (encoded) using either 8 or 16 bits. The more bits, the more accurate the sound reproduction. 8-bit sound is adequate for voice. 16-bit sound is used in the creation of music CDs.
Direct Memory Access (DMA) enabled, buffered transfer capability	The sound board must be able to buffer the digital sound and have an efficient transfer across the PC bus for smooth recording and playback.
Sampling rates of 44.1, 22.05, and 11.025KHz	An analog signal sampling rate should be twice the frequency of the analog signal for an accurate reproduction of the sound. The highest pitch common to human speech is about 6KHz. Therefore, you can get a fair reproduction of human speech with an 11.025KHz sampling rate. Quality music reproductions require 44.1KHz.
Music synthesizer	Many sound boards use the same synthesizer (the Yamaha OPL3) as Creative Labs' Sound Blaster line of boards. Using a board with this chip helps ensure compatibility with software applications.
CD-ROM XA capable recommended	Refers to photo CD compatibility. Photo CD was developed by Kodak for displaying pictures on computers or on a common television with an attached photo CD player. Several photo CD stock photo packages are available along with software tools to edit and manipulate photo CD graphic images.
ADPCM support recommended	ADPCM is a compression standard for sound files. This Microsoft wave file format offers 4:1 compression. Software drivers are available, and many sound boards now support this standard in hardware.

audio board and CD-ROM that use a SCSI interface. These boards are slightly more expensive, but may provide better protection against obsolescence. Also, your safest bet is to select an audio board from one of the "Big Three":

1. Creative Labs, maker of the Sound Blaster line of boards, supplies lots of good utilities and small applications with its boards. Creative Labs has good quality boards, competitive pricing, and excellent technical support.
2. Media Vision, the maker of the Pro Audio boards, has an impressive array of multimedia upgrade kits with quality components such as NEC double- and triple-speed CD-ROM drives. Media Vision also has good quality products and bundles useful utilities with its boards. Media Vision was one of the first audio board manufacturers to use a standard SCSI interface.
3. Turtle Beach is best known for its high-quality boards and useful utilities. Some Turtle Beach boards are more expensive than boards from Creative Labs or Media Vision, but contain high-end features and capabilities that appeal to musicians or multimedia authors. Turtle Beach also offers many fine applications and utilities for working with sound files.

Choosing speakers (or headphones) for these boards depends on individual taste and what application and setting they will be used in. Generally, U.S. $10 speakers sound pretty bad, and U.S. $300 speakers sound great. The Roland CS-10 Stereo Micro Monitor sits nicely under a monitor on your desktop, has easy-to-access controls, and does a good job for about U.S. $45. If you are doing presentations to an entire room, check out Altec Lansing speakers in the U.S. $125 to $150 price range. They deliver a lot of sound in a small package.

Standard MPC2 hardware (486SX 25MHz) is sufficient for recording and playback of all standard sound files. However, a fast hard disk is helpful in recording and playback of sound files. Other factors affecting the storage of sound files are listed below:

- Performance may suffer if the disk uses compression (such as found in MS DOS 6.0 or Novell DOS 7).
- Fragmentation of files may cause problems. Make defragmentation a regular part of your PC maintenance program.
- Consider using utilities and drivers designed especially for the compression of sound files.
- Select hardware and software that supports recording at various speeds, resolution, and modes.
- For the widest possible distribution, take advantage of the multimedia utilities included with MS Windows 3.1. (See "MS Windows and Multimedia," p. 20.)

If you follow these guidelines, you can start a fairly painless implementation of multimedia on your workstations. There are other considerations for networked sound files, but these will be discussed in the next issue of *NetWare Connection*.

Vivacious Video

If a picture is worth 1,000 words, video is worth 1,000 words 30 times a second. When the triangles smashing together were being described in the introduction to this article, your imagination might have conjured up some images, but having the flash of collision light up your face, leaving black tracers in the middle of your field of vision, drives the senses into another dimension. This is video, the medium that combines the most vivid human senses, sight and sound, and it is available now on your PC. Sound exciting?

Don't get too excited yet. Of all the multimedia elements, video poses the

Multimedia PC Standards

The Macintosh has always enjoyed standardized interfaces for hardware and applications. Until recently, however, the PC has not enjoyed such standards. MS Windows 3.0 established the first widely accepted standard user and application interface for the PC, but provided no real hardware standards.

Multimedia technology and the resulting multimedia craze created an environment that demanded standardization. Recognizing the situation, multimedia and PC vendors joined together in 1990 to create the Multimedia PC (MPC) Marketing Council. From this group came a standard for the implementation of the multimedia PC platform called MPC Level 1. This standard is recognized around the world for the hardware implementation of multimedia on the PC.

In May 1993 the MPC council announced the Multimedia PC Level 2 (MPC2) specification, which is an enhanced performance specification of the original standard.

Vendors identify MPC-compliant products with the MPC certification logos (shown above). The logos are licensed by more than 130 vendors to verify that products meet or exceed the MPC (MPC level 1) or MPC2 (MPC level 2) specifications.

When you purchase a multimedia PC or upgrade your current PC, we recommend that you look for the MPC certification logo to ensure that the product meets the minimum multimedia standards. This can save you major compatibility headaches as you put together your multimedia PC.

Minimum Multimedia PC Level 1 System Requirements

Hardware

386SX or higher processor
2MB RAM
30MB hard disk
VGA or VGA+ display
Two-button mouse
101-key keyboard
Serial port, parallel port
Musical Instrument Digital Interface (MIDI) I/O port
Joystick port
Headphones or speakers connected to your computer

CD-ROM Drive

CD-DA outputs, sustained 150kbyte/s transfer rate without consuming more than 40 percent of CPU bandwidth
Average seek time of 1 second or less
MSCDEX 2.2 driver or equivalent that implements the extended audio Application Program Interfaces (APIs)
Subchannel Q support (P, R-W optional)

Audio Board

8-bit Digital-to-Audio Converter (DAC), Linear PCM sampling 22.05 and 11.025KHz rate, Direct Memory Access/First In, First Out (DMA/FIFO) with interrupt
8-bit Analog-to-Digital Conversion (ADC), Linear PCM sampling, 11.025KHz rate, microphone level input
Music synthesizer
Onboard analog audio-mixing capabilities

System Software

Binary compatibility with MS Windows 3.0 plus Multimedia Extensions or MS Windows 3.1

Minimum Multimedia PC Level 2 System Requirements

Hardware

486SX 25MHz or compatible microprocessor
4MB RAM (8MB recommended)
Video display resolution of at least 640 x 480 with 65,536

biggest challenge to current PC technology. This is mostly due to the vast amounts of data and processing power required to reproduce video on a PC.

To give you an idea of the sheer size and power involved when we say "vast," let's look at some numbers. Playing one minute of full-screen (640 x 480) video from one of your favorite videotapes requires about 1.6GB of storage space. That's about 144GB for a basic 90-minute video! You would need about 288 500MB hard drives or 240 CD-ROMs to store an entire video. Although data storage has become relatively inexpensive, at that rate, not many of us could afford to store *Mrs. Doubtfire* on our PCs.

In addition to storing large amounts of data, PCs would have to read and process about 27Mbyte/s. The fastest SCSI hard drives can deliver about 10Mbyte/s; a double-speed CD-ROM about 300kbyte/s. And we haven't even added the soundtrack yet! Sound requires between 5.3Mbyte/s (mono) and 10.5Mbyte/s (stereo).

For the sake of argument, let's assume the data can be provided at the necessary rate. To actually display the video, the PC's CPU has to decompress and display up to 30 bit-mapped frames per second!

We hinted at the beginning that video on the PC was a reality, but based on the preceding numbers, how can that be? In a word, compromise. You must compromise the size and/or quality of the picture to reduce the amount of data to a level that can be handled by the PC.

The first and most important technique is to reduce the amount of data that needs to be processed using video compressors called CODECs (short for compressor/decompressors). All CODECs require hardware to capture video even though they may use software compression. Most MS Windows CODECs, however, do not require hardware to play back the video. Common MS Windows CODECs are Cinepak, Indeo 3.0, and Microsoft Video 1. These compression techniques can compress video data at rates up to 25:1. CINEPAC by SuperMac Technologies, Inc., was developed initially for the Macintosh and is the common CODEC used for Macintosh video compression.

The disadvantage to the software decompression playback is that at 25:1 compression, the PC must still process about 1.2Mbyte/s for full-screen video. Faster hard drives can supply data at this speed, but video is typically shipped on and played from CD-ROMs, which run at 150kbyte/s (double-speed units up to

(64KB) colors
Two-button mouse
101-key keyboard (or functional equivalent)
Serial port
Parallel port
MIDI I/O port
Joystick port
Headphones or speakers connected to your computer

CD-ROM Drive
Double speed with CD-DA outputs (capable of sustained 300kbyte/s transfer rate)
No more than 40 percent of the CPU bandwidth may be consumed when maintaining a sustained transfer rate of 150kbyte/s.
Average seek time of 400 milliseconds or less
10,000 Mean Time Between Failure (MTBF)
CD-ROM XA ready (mode 1 capable, mode 2 form 1 capable, mode 2 form 2 capable)
Multisession capable
MSCDEX 2.2 driver or equivalent that implements the extended audio APIs
Subchannel Q support (P, R-W optional)

Audio Board
16-bit DAC, Linear PCM sampling, 44.1, 22.05, and 11.025KHz rate, DMA/FIFO buffered transfer capability
16-bit ADC, Linear PCM sampling, 44.1, 22.05, and 11.025KHz rate, DMA/FIFO buffered transfer capability, microphone input
Music synthesizer
Onboard analog audio-mixing capabilities
CD-ROM XA audio capability recommended
Support for the IMA-adopted ADPCM software algorithm recommended

System Software
Binary compatibility with MS Windows 3.0 plus Multimedia Extensions or MS Windows 3.1

Contacting the MPC Marketing Council

The MPC specifications have helped to ensure the compatibility of multimedia PCs and related peripheral products. For more information about the MPC specifications, contact the Multimedia PC Marketing Council:

Multimedia PC Marketing Council
1730 M Street N.W., Suite 707
Washington, D.C. 20036
1-202-331-0494
FAX: 1-202-785-3197 ■

300kbyte/s and triple speed up to 450kbyte/s). Even if the CD-ROM could read 1.2Mbyte/s, it is still to much to ask of the PC's CPU to decompress that much data and display it on the screen at 30 frames per second.

To reduce the amount of data to a level sufficient for playback from a CD-ROM and at a rate that most processors can keep up with, you have to compromise the size of the picture. Instead of a full 640 x 480 screen, you reduce the size to 320 x 240 or even 160 x 120. This reduction in size is sufficient to allow playback of video files from a CD-ROM using CODECs without additional hardware in the form of video coprocessors. The CODECs previously mentioned can be used with special hardware that provides video coprocessors to assist in playback and gives you a larger video window at higher frame rates.

Another type of CODEC that has recently been adapted to the PC is Motion Picture Experts Group (MPEG). MPEG has compression levels up to 100:1 and allows full-screen video playback from a CD-ROM. The disadvantage is the requirement for additional hardware to handle the video decompression for playback because the video was hardware and not software compressed. A year ago, you couldn't buy MPEG playback adapters for less than about U.S. $2,000. Today companies such as Sigma Designs offer MPEG playback adapters for as little as U.S. $350.

Some other compromises that can reduce the video data size even more deal with frame rate and the number of colors. U.S. standard video—National Television Standards Committee (NTSC)—has a frame rate of 30 frames per second. If we reduce this rate when we capture and compress the video to a file, the amount of data will be reduced accordingly. Fifteen frames per second is a typical compromise rate used by most CODECs, although many give you options (including 30 frames per second) for the capture.

MS Windows and Multimedia

Multimedia as an integral part of an IBM PC was not a reality until Microsoft introduced Windows 3.1. Windows 3.1 gave the PC what the Macintosh has always had, a common graphical user interface (GUI) and a standard interface between applications and the PC's hardware. This introduced an environment where standards could be created and imposed.

Once the Windows interface specifications for multimedia hardware had been defined and drivers created based upon those specifications, application developers could make requests to Windows for particular multimedia hardware functions without worrying about creating a driver for the particular hardware. For example, if an application developer wanted to play an audio file, the application could make the request to Windows, and Windows would interface with the sound board to play the file.

As a result, the sound board vendor would only have to create a single device driver that could be used by any application. This environment encouraged development of both multimedia hardware and applications. It also promoted a feeling of uniformity and standardization that eases users' anxiety about spending money for these types of systems.

The Windows standards that are critical to multimedia applications are the MPC Level 1 and Level 2 system specifications (see "Multimedia PC Standards," pp. 18-19), Video for Windows, the Media Control Interface (MCI) Application Program Interfaces (APIs), and Object Linking and Embedding (OLE).

Video for Windows

Video for Windows is a group of standards for playing video files in the Windows environment. The most significant of these standards is the Audio Video Interleaved (AVI) file format. With AVI, a compressed video file is interleaved with the audio file on a per-frame basis (one frame of video, then its audio track; then another video frame and its audio track; and so on).

The AVI standard is very flexible and specifies the interface but not how the actual task is accomplished. For example, the AVI specification dictates how the video will be stored with the audio on the storage medium. It does not specify how the video is to be compressed, decompressed, or how the video hardware will display the images. This gives developers plenty of room for developing new technologies and encourages a diversity of product ranging from low-end, low-cost products to sophisticated high-end products.

MCI Application Program Interface

MCI provides calls to play and control different types of media in Windows. Used by programmers, these calls run and control audio, video, animation, Musical Instrument Digital Interface (MIDI), and other multimedia functions, files, and hardware within their applications. These calls are independent of the multimedia hardware.

OLE

The OLE standard allows you to link or embed a media clip into a Windows application as long as both of the applications (the one you are embedding the file into and the application that will play or display the file) support the OLE specification. For example, you can copy and paste an AVI file of yourself into the MS Word document that is your resume. MS Word supports OLE as does Media Player, which is the application that will actually play the video file. When you paste the file you copied from Media Player into the MS Word document, the Media Player icon appears. When a prospective employer opens the document and clicks on the icon, the video plays (assuming Video for Windows is installed).

The following are multimedia applications that are included with MS Windows and can be found in the Accessories program group:

Media Player. Included with MS Windows 3.1, Media Player plays audio, video, MIDI, and animation clip files. The type of clips Media Player can play depends on what type of hardware drivers are installed. Installed drivers will appear under the Windows Device menu. For example, if you have a sound board installed, the media play capabilities that could appear in the Device menu are Sound, MIDI sequencer, CD Audio, and so on.

Sound Recorder. If you have a sound board installed that supports recording and a microphone (or other supported audio source), you can record and do some minor editing of a .WAV audio file.

Object Packager. This utility allows you to embed a file into an application that does not support the OLE specification. ■

Color should be your last option for reducing data. Most CODECs capture video at 24-bit color but play well on 64KB (16-bit) or 256KB (8-bit) color systems. Most compression techniques are sufficient so that you shouldn't have to capture video at 8-bit color levels.

Now that we have compressed the video to a manageable size, we can play back video from a CD-ROM or hard drive. But video can be pretty boring without sound. Although sound doesn't require nearly the amount of space that video does, it presents other obstacles to video playback. Keeping the audio in sync with the video is the biggest problem. Most people have a low tolerance of voices that do not match the movement of the lips. They have an even lower tolerance of audio that is skipped altogether.

The other problem is the seek time of hard drives and CD-ROMs. If the video and audio tracks are in separate files, the PC has to constantly seek back and forth between them. A fast hard drive has an average seek time of about 10-12 milliseconds, a CD-ROM about 250 milliseconds. Again, most video is played from CD-ROM. If the audio and video were on separate tracks, the CD-ROM could not seek fast enough to keep up with playback.

To solve the separate audio and video track problem, Microsoft created the Audio Video Interleaved (AVI) file format. (The Macintosh has a similar format called QuickTime that is also available for Windows.) The AVI format takes the compressed video file and interleaves it with the audio file on a per-frame basis—for example, one frame of video and then its audio track, then another frame and its audio track, and so on.

AVI does not dictate how the video or audio will be compressed or played back, only how it will be stored on the disk. This means the AVI format can continue to be a standard even as compression and playback technologies advance.

The AVI file format eliminates the need for CD-ROMs to seek and takes advantage of a CD-ROM capability called streaming, which is ideal for video playback. A CD-ROM can read a single track from start to finish, unlike a hard drive that stores things in blocks that may not be contiguous. This means the CD-ROM can easily provide a constant stream of interleaved video and audio without seeking.

Even using all the compression techniques and AVI format, a PC sometimes cannot supply data fast enough to keep up with the video playback. In these cases, most video playback software has been designed to systematically drop video frames while playing the complete audio track and maintaining audio synchronization. People can tolerate a little jerkiness in the video as long as the audio is not fragmented and remains in sync.

Implementing Video on Your PC

To play back AVI files on an MPC Level 1 or 2 PC, you need only to install Video for Windows. You can purchase Video for Windows by itself, but it is bundled in the products of many multimedia vendors. To play an AVI video, complete the following steps:

1. Open Media Player from the Accessories program group.
2. Select Video for Windows from the Device menu.
3. Select a file with an .AVI extension on your hard drive or a CD-ROM. (Video for Windows and most products that include it contain sample video files.)
4. Click on the Media Player play button.

Conclusion

Video for the PC is a competitive market, and that competition is driving rapid advances in video technology while bringing prices down. The winners in all this competition are us, the users. It is not inconceivable that some of the limitations to video on the PC mentioned in this article will have been eliminated by the time you read it. For example, it won't be long before video coprocessors are widely available as an integrated part of the PC, allowing for larger video windows and higher frame rates. Keep your eyes open—there are exciting times ahead for the senses and for video on the PC.

The next issue of *NetWare Connection* will focus on the issues facing multimedia on the network.

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Jargon, Acronyms, and Other Interesting Terms

ADC (Analog-to-Digital Converter)
The Analog-to-Digital Converter (ADC) takes analog signals, such as sound waves, and converts them to digital form for storage or manipulation.

ADPCM (Adaptive Differential Pulse Code Modulation)
A Microsoft wave file format offering the advantage of 4:1 compression.

analog sound
Analog sounds have a signal that varies continuously. To be used or stored on a computer, analog sound must be converted to a digital format.

authoring tool
A program used to combine elements such as graphics, navigational tools, animation, sound, and video into a multimedia product.

AVI (Audio Video Interleave)
A standard file format for Video for Windows, which specifies how audio and video data are mixed in a single file. A compressed video file is interleaved with the audio file on a per-frame basis.

BMP format
An MS Windows-specific bitmap graphic format that is vector based. Supported by many graphical applications, such bitmap files are identified with the three-digit extension .BMP.

CBT (Computer-Based Training)
A training method that uses the computer to present lessons and grade user performance.

CD-ROM (Compact Disc-Read Only Memory)
Laser-encoded optical storage medium that can hold up to 600MB of information. CD-ROM is an ideal distribution format for multimedia applications that support large video, audio, and animation files.

CD-ROM XA
A data-encoding and storage standard developed by Kodak for displaying pictures on computers or on a common television with an attached photo CD player.

CODEC (COmpressor/DECompressor)
Created from the two words *COmpressor/DECompressor*, CODEC is the generic term for the driver that is used by Windows to compress or decompress digital video.

DAC (Digital-to-Audio Converter)
Digital-to-Audio Converters (DACs) process digital information to recreate an analog signal.

DIB (Device Independent Bitmap)
Image format that allows files to be displayed on a variety of devices.

digital sound
Sound represented digitally by sampling an analog waveform and converting it to digital format.

DVI (Digital Video Interactive)
A set of video processors and software that allows manufacturers to create a digital, multimedia PC or platform.

EPS (Encapsulated PostScript)
A graphic file format that stores an image using PostScript codes.

FM synthesizer
Device that creates electronically synthesized music by combining a group of waveforms and frequencies to form a new waveform. Most sound boards include an FM synthesizer chip.

GIF (Graphics Interchange Format)
A graphic file format that compresses images. GIF was created for use on CompuServe, an electronic information service.

GUI (Graphical User Interface)
Visual configuration using icons for tasks and functions.

High Sierra format
A standard format that preceded ISO 9660 and defined the table of contents and directory structure of CD-ROMs used for computer applications.

hypertext
Linked information that allows users to cross-reference or search through information on a "need-to-know" basis. For example, users can click on an image or word and receive more information on the image or word.

interactive
Requiring the active participation of the user in determining the flow of the multimedia program.

ISO 9660
The standard for CD-ROM table of contents and directory structure for computer applications. Based on the High Sierra format.

JPEG (Joint Photographic Experts Group)
Standards group that defined a file format and image compression format called JPEG. The JPEG format uses "lossy" (not lousy) compression that actually loses some of the graphic information upon compression. This process is based on the premise that the human eye cannot detect the lost information.

kiosk program
A program that does not require active participation to move through it.

MIDI (Musical Instrument Digital Interface)
Industry-standard connection enabling musical instruments, such as keyboards and electric guitars, to be controlled by a computer system.

MPC (Multimedia Personal Computer)
Originated by Microsoft Corporation, MPC is a trademark now owned by the Multimedia Marketing Council (MMC). The MMC defines specifications for multimedia components and computers.

MPEG (Motion Picture Expert Group)
Group formed to work on compression/decompression of motion video with digital audio. The MPEG group is defining and redefining the MPEG standard.

MSCDEX (Microsoft Compact Disc Extensions)
A driver (MSCDEX.EXE) loaded as a DOS terminate-and-stay resident (TSR) program. The driver allows a CD-ROM to be accessed through DOS commands applicable to hard disk and floppy disk drives.

multimedia
A product that includes various media elements, such as text, graphics, animation, and video.

NTSC (National Television Systems Committee)
NTSC is the video standard for North America and many countries.

OLE (Object Linking and Embedding)
OLE is a Windows interface standard that allows multimedia files to be embedded and run from within another application.

PAL (Phase Alternating Line)
PAL is the video standard for Europe, except France.

photo CD
The photo CD was developed by Kodak to allow storage of photos on CDs rather than as negatives, prints, or slides. Images can be "played" from the CD for display on a TV (using a special player), or the images can be used in desktop publishing or multimedia applications.

PCX
Older graphic file format that is not supported by MS Windows. To open, view, or edit a PCX file in the Windows environment, you must install a graphics program that supports this format.

pixel (PICture ELement)
Short for PICture ELement, a pixel is the smallest element a screen can display. That is, each small dot of light displayed on your computer screen is one pixel.

QuickTime
A method for digital imaging and audio multimedia mixing. Trademark of Apple Computer, Inc.

raster image
Image type composed of pixels.

rendering
Rendering is the process of creating a stationary or animated image by combining information about a scene's geometry, materials (such as a bumpy cloth pattern used for chair upholstery), lighting, camera locations, and finally, movement paths.

sampling rate
A measure of a digital sound sample's resolution. Standard sample rates are 11.025, 22.05, and 44.1KHz. To obtain a more accurate representation of a sound, you should increase the sampling rate.

SECAM (Sequential Couleur Avec Memoire)
SECAM is the video standard for France.

SCSI (Small Computer System Interface)
SCSI was designed for fast data transfer in PCs. SCSI is often used for large hard disk drives or CD-ROM drives.

TGA (Targa)
Popular file format for high-resolution 24-bit images.

TIFF (Tagged Image File Format)
Older graphic file format that is common in the desktop publishing world. Recent versions of TIFF allow for image compression.

vector image
Image type composed of instructions used to reconstruct objects in the image.

waveform
A waveform is a representation of an analog signal, such as a sound. A waveform file stores data needed to reconstruct the waveform that produced it.

WMF (Windows Metafile)
Image format that is a vector format but can combine both vector and raster images. ■