Chapter 12

Audio Hardware

For many years, the PC lacked a voice. While the Apple Macintosh and Commodore Amiga have long had standardized, high-quality sound, the typical PC features an impish two-inch speaker stuffed inside the computer's case.

Then the sound revolution came. PC owners can now buy sound cards, which give their software the capability to speak and sing. By buying the Sound Blaster Pro, Pro AudioStudio 16, Microsoft Sound System, or any of several other sound card models and makes, you can give your PC a voice.

At first, sound cards were used only for games. The first sound cards for the PC were the AdLib Music Synthesizer Card ($195) and the Roland MT-32 Sound Module ($500). In 1989, Creative Labs developed the Game Blaster, which was distributed by Brown-Wagh Publishing. The Game Blaster provided stereo sound to a handful of computer games. The question for many buyers was, "Why spend $100 for a card that adds sound to a $50 game?" More importantly, because no sound standards existed at the time, a sound card might be useless with other games.

A few months after releasing the Game Blaster, Creative Labs announced the Sound Blaster sound card, which originally sold for $239.95. The Sound Blaster was compatible with the AdLib sound card and Creative Labs' own Game Blaster card. It included a built-in microphone jack and a MIDI (Musicial Instrument Digital Interface) interface for connecting the PC to a musical synthesizer. Finally, the sound card had uses besides games.

Sound Card Applications

Unfortunately, sound cards have no standards. As in other aspects of the computer industry, the standard is developed by the market leader. For example, Hayes-compatible modems use the escape codes used by Hayes Microcomputer Products Inc. to connect two computers. (Hayes now collects royalties from many modem manufacturers who use their codes.)

Over the last few years, sound card manufacturers have fought for dominance. Today a sound card may be touted as AdLib-compatible or Sound Blaster-compatible. (The de facto standard is Sound Blaster.) Until the anemic speaker built into the PC is replaced by a standard sound chip, however, adding a Sound Blaster sound card hardly constitutes a standard.

Despite the lack of standards, a sound card has many uses, including the following:

- Adding stereo sound to entertainment (game) software
- Forming the backbone for multimedia
- Adding sound effects to business presentations and training software
- Creating music, using MIDI hardware and software
- Making screen savers talk
- Adding voice notes to Windows files
- Adding sound effects to Windows
- Giving a PC voice commands
- Turning a PC into a proofreader
- Playing audio CDs from DOS and from within Windows

Games

The sound card originally was designed to play games. In fact, many sound cards include *joystick ports*—connectors for adding a game joystick. Typically, you tell your game software that you have a sound card and to avoid using the PC's speaker (see fig. 12.1).

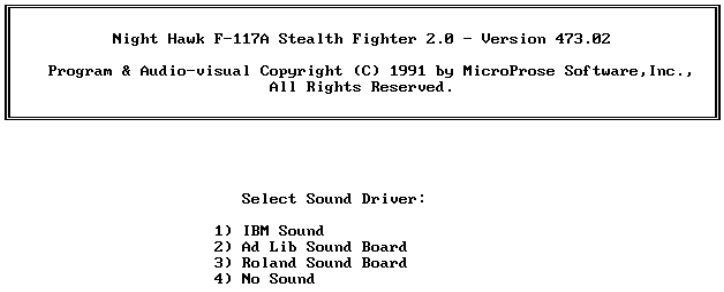

Fig. 12.1
In many games, such as F-117A Stealth Fighter from MicroProse, you select the sound card you have.

The result is that the games take on human qualities. For example, the CD-ROM game *Sherlock Holmes, the Consulting Detective*, from Icom Simulations, uses recorded human voices and film clips. In this game you navigate through London, attempting to solve three different mysteries. Each new location brings up a 30- to 90-second film clip of actors portraying characters, including Holmes and Dr. Watson. The dialogue comes from the digitized voices of real actors.

Similarly, games such as *Monkey Island*, from LucasFilm Games, have beautiful musical scores. In Monkey Island, you become the character Guybrush Threepwood, roaming the Caribbean to become a pirate. To fit the tropical scenes, Monkey Island's musical score includes reggae music.

Multimedia

A sound card is a prerequisite if you want to turn your PC into a *multimedia* PC (MPC). What is multimedia? The term embraces a gamut of PC technologies. Basically, multimedia means the ability to merge voice, images, data, and video on a computer. Multimedia applications range from talking encyclopedias to databases of stored video clips.

An organization called the Multimedia PC (MPC) Marketing Council was formed to generate "standards" for multimedia. This group of hardware and software manufacturers already includes Tandy, Philips Electronics, NEC, and other big names. The group defines a multimedia PC as a computer having at least the following elements:

- 25-MHz 80486SX processor
- Double-speed CD-ROM drive that is CD-ROM XA ready
- 16-bit audio card
- 640 × 480 VGA card displaying 65,536 colors
- 4M RAM
- 160M hard disk
- A pair of speakers
- 1.44M (high-density) 3 1/2-inch disk drive
- MIDI interface
- Microsoft Windows 3.1

(This list is based on the second version of the MPC specifications, which are also called MPC-2 or MPC Level 2 specifications.)

The MPC-2 specifications are the *bare minimums*. In fact, the MPC Marketing Council sometimes raises these standards a notch or two.

A sound card is the backbone of an MPC. (In fact, many sound cards include a built-in connection for the CD-ROM drive.) What can you do with an MPC? Most multimedia software packages are designed for education, entertainment, or reference. With a CD-ROM disc's capability to hold so much information (up to 660M), you can provide the equivalent of volumes of static historical information on one disc. For example, one CD-ROM can hold the equivalent of an encyclopedia boot set.

One of the more impressive CD-ROM discs is Microsoft's *Multimedia Beethoven: The Ninth Symphony*. Professor Robert Winter, an authority on Beethoven, guides the user into appreciating Beethoven and his Ninth Symphony. Six sections focus on different aspects of the man and his work. The Art of Listening section, for example, teaches you how to appreciate music and applies those same principles to this particular symphony. You can select and listen to certain passages while the actual notes are displayed on the screen.

MIDI

If you're musically inclined, you'll enjoy MIDI (Musicial Instrument Digital Interface). Developed in the early 1980s, MIDI essentially is a powerful programming language that lets your computer store and edit or play back music in tandem with a MIDI-compatible electronic musical instrument, typically a keyboard synthesizer.

The MPC specs mentioned earlier call for MIDI support. With a MIDI interface, you can compose and edit music for presentations, learn about music theory, or turn your PC into a one-stop music mixing studio.

MIDI makes a musical note sound as though it comes from any of a wide array of instruments. The MPC specifications require a sound card to contain an FM MIDI synthesizer chip and be able to play at least six notes simultaneously.

To connect a MIDI device to a PC, you need a sound card that has two round serial ports in back—a MIDI input port and a MIDI output port. In addition to a keyboard, you'll need sequencing software to modify the tempo, sound, and volume of your recordings, or to cut and paste together various prerecorded music sequences.

Unlike other sound files, MIDI messages require little disk space. An hour of stereo music stored in MIDI requires less than 500K. (To contrast, a Microsoft Windows digital sound (WAV) file, consumes over 1,000 times that.)

Presentations

Businesses are discovering that combining graphics, animation, and sound is more impressive, and often less expensive, than a slide show. A sound card adds pizzazz to any presentation or classroom.

A variety of business-presentation software and high-end training and authoring packages already exist. And you don't have to be a programmer to get your own show on the road. Among the packages you can use to incorporate multimedia elements into your show are Asymetrix Corporation's Make Your Point and Macromedia's Action. Even such popular software packages as CorelDRAW! and PowerPoint now include rudimentary sound and animation features for their presentation files.

Some presentation software packages support MIDI. With these products you can synchronize sounds with objects. When a picture of a new product is displayed, for example, you can play a roaring round of applause. You can even pull in audio from a CD in your CD-ROM drive. Such presentation software programs include clip-media libraries.

A sound card can make tasks (such as learning how to use software) easier. PC software manufacturers have taken an early lead in this area. Microsoft and Lotus, for example, are already shipping special CD-ROM versions of some of their products. These versions include animated on-line help, replete with music.

You can even take your show on the road. Some special external sound cards attach to a laptop computer's parallel port to provide audio on the go. And some laptops include built-in audio. For example, Texas Instruments' line of 4000M laptops include multimedia capabilities.

Screen Savers

A *screen saver* is a software program that either blanks the screen or replaces it with moving images after a preset period of time. Why? If you leave your current work, such as a document, displayed on the screen, the monitor's electron beams may permanently etch the static image into the screen's phosphor surface. Screen savers often include passwords to protect your work from by prying eyes. Microsoft Windows 3.1, for example, has a built-in screen saver with password protection.

Your Microsoft Windows screen saver may blank the screen but not your ears. Some screen savers, such as After Dark for Windows and Intermission, now include sounds. In After Dark the nocturnal module howls and chirps, the aquatic scene bubbles, and the space toasters flap their wings. In Intermission you'll find a dancing pig and an ant farm.

Recording

Virtually all sound cards have an audio input jack. With a microphone, you can record your voice. Using the Microsoft Windows 3.1 Sound Recorder, you can play, edit, or record a sound file. These files are saved as WAV files, a type of file format. In the Windows Control Panel, you can assign certain Windows events a specific WAV file (see fig. 12.2). You might use a loud "Ta-da" to announce the starting of Windows, for example.

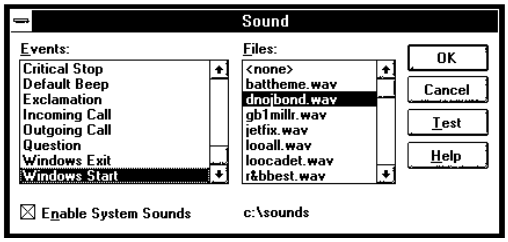

Fig. 12.2
The Sound section of the Windows Control Panel adds sound to different Windows events.

By recording your own sounds, you can create your own WAV files. Then you can use them for certain events. These are the standard events:

- Windows Start
- Windows Exit
- Default beep
- Asterisk
- Critical Stop
- Question
- Exclamation

Through the same audio input jack, you can attach your stereo system and record a song to a WAV file. You can also purchase prepackaged WAV files. Prerecorded WAV files can also be found on your local electronic bulletin board or on-line services such as CompuServe and America Online.

Voice Annotation

Using WAV files, you can record messages into your Windows documents and spreadsheets. For example, a business executive could pick up a microphone and, by embedding a message in a contract, give his or her secretary explicit instructions. This message is called a *voice annotation* (but think of it as a verbal Post-It note).

With voice annotation you can embed voice messages, suggestions, or questions in a document and send them to a colleague. To leave such messages, your Windows application must support Windows' Object Linking and Embedding (OLE) feature.

Imagine that you're editing a worksheet in Excel and want to insert a voice note next to a total that looks questionable. Place the cursor in the cell next to the total, then select **E**dit, **I**nsert, **O**bject, **S**ound to call up Windows' Sound Recorder. Click on the Record button and begin speaking.

Voice Recognition

Imagine giving your PC spoken commands from within Microsoft Windows. Some sound cards are capable of voice recognition. For example, the Pro AudioStudio 16, from Media Vision, includes voice-recognition software. You can also get voice recognition for your current sound card. IBM and Dragon Systems are marketing the Dragon Talk-To Plus software package ($149) for simple voice-command control of Windows applications. Voice-recognition technology is not perfect and you need a speedy computer, such as a 486DX4 or Pentium, for quick response times.

Proofreading

Sound cards can be used also as inexpensive proofreaders. Text-to-speech utilities can read back to you a list of numbers or text.

Monologue, a text-to-speech utility ($149) from First Byte Inc., is included with the Pro AudioStudio 16 sound card. You can have this text-to-speech utility loaded in the background while you are using your spreadsheet or word processor. Say, for example, that you are entering columns of numbers in Lotus 1-2-3. When you want to check your work, just highlight the numbers and press a hot key. Monologue begins to read back the highlighted numbers. Monologue can also read back an entire file.

You can change the speed and volume of Monologue's voice and change the pitch to resemble a male or female voice. You can even add words to a dictionary of exceptions in which you teach Monologue how to speak "correct" English. Windows versions of text-to-speech utilities also are available. Monologue for Windows ($149) reads back text you copy into the Windows Clipboard.

What are the practical uses for a text-to-speech utility? Forgotten words or awkward phrases may be easier to spot when you hear a letter read. Accountants can double-check spreadsheet numbers, and busy executives can listen to their E-mail while they are doing paperwork.

Audio CDs

Microsoft Windows can also play audio CDs while you are working on something else. The music can be piped not only through a pair of speakers but also through a headphone set plugged into the front of your CD-ROM drive.

Some sound cards include a DOS-based CD-player utility, although free versions are available on online services such as CompuServe. For example, the Sound Blaster Pro includes CD Player. With the DOS-based utility, however, you cannot use another program while the CD utility is in use (as you can with its Windows counterpart). However, you can exit the DOS CD utility, letting the audio CD play uncontrolled.

Sound Card Concepts and Terms

To understand sound cards, you need to understand various concepts and terms. Words like *16-bit*, *CD-quality*, and *MIDI port* are just a few. Concepts such as *sampling* and *digital-to-audio conversion (DAC)* are often sprinkled throughout stories about new sound products. The following sections describe some common sound card terms and concepts.

The Nature of Sound

To understand a sound card, you need to understand sound itself. Every sound is produced by vibrations that compress air or other substances. These sound waves travel in all directions, expanding in balloon-like fashion from the source of the sound. When these waves reach your ear, they cause vibrations that you perceive as sound.

The two basic properties of any sound are its *pitch* and its *intensity*.

Pitch is simply the rate at which vibrations are produced. It is measured in the number of hertz (Hz), or cycles per second. One cycle is a complete vibration back and forth. The number of Hz is the frequency of the tone; the higher the frequency, the higher the pitch.

You cannot hear all possible frequencies. Very few people can hear fewer than 16 Hz or more than about 20 kHz (*kilohertz;* 1 kHz equals 1,000 Hz). In fact, the lowest note on a piano has a frequency of 27 Hz, the highest note, a little more than 4 kHz. And frequency-modulation (FM) radio stations broadcast notes up to 15 kHz.

The intensity of a sound is called its *amplitude*. This intensity depends upon the strength of the vibrations producing the sound. A piano string, for example, vibrates gently when the key is struck softly. The string swings back and forth in a narrow arc and the tone it sends out is soft. If the key is struck forcefully, however, the string swings back and forth in a wider arc. The loudness of sounds is measured in *decibels* (db). The rustle of leaves is rated at 20db, average street noise at 70, and nearby thunder at 120.

Game Standards

Most sound cards support both of the current entertainment audio standards: *AdLib* and *Sound Blaster*. The Sound Blaster Pro is a sound card sold by Creative Labs; Ad Lib sells the Ad Lib Gold. To play most games, you must tell your game which of these sound card standards your sound card supports. (Some games support only one or the other.) Some sound devices support neither of these game sound standards. The Logitech AudioMan, for example, was meant for business, not fun.

Frequency Response

The quality of a sound card is often measured by two criteria: *frequency response* (or *range*) and *total harmonic distortion*.

The frequency response of a sound card is the range in which an audio system can record and/or play at a constant and audible amplitude level. Many cards support 30 Hz to 20 kHz. The wider the spread, the better the sound card.

The total harmonic distortion measures a sound card's linearity, the straightness of a frequency response curve. In laymen's terms, the harmonic distortion is a measure of accurate sound reproduction. Any nonlinear elements cause distortion in the form of harmonics. The smaller the percentage of distortion, the better.

Sampling

With a sound card, a PC can make noise in three ways. *Waveform audio* (also known as *sampled* or *digitized sound*) uses the PC as a tape recorder. Small computer chips built into a sound card, called *analog-to-digital converters* (ADCs), convert analog sound waves into digital bits the computer can understand. Likewise, *digital-to-analog converters* (DACs) convert the recorded sounds to something audible.

Sampling is the process of turning the original analog sound waves (see fig. 12.3) into digital (on/off) signals that can be saved and later replayed. Snapshots of the analog sounds are taken and saved. For example, at time X the sound may be measured with an amplitude of Y. The higher (or more frequent) the *sample rate*, the more accurate the digital sound is to its real-life source.

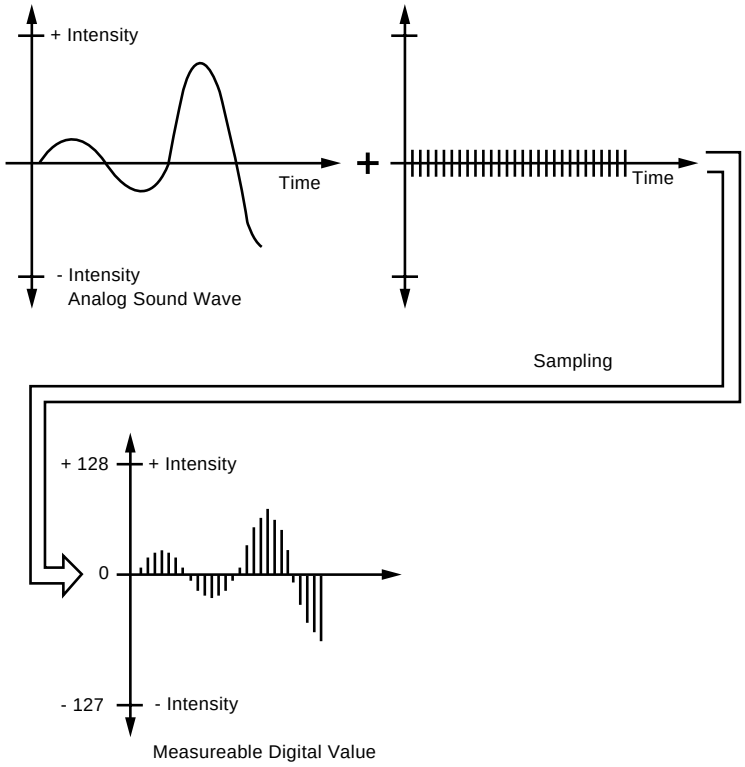

Fig. 12.3
Sampling turns a changing sound wave into measuerable digital values.

8-Bit versus 16-Bit

The original Multimedia PC (MPC) specifications required 8-bit sound. This doesn't mean the sound card must fit into an 8-bit instead of a 16-bit expansion slot. Rather, *8-bit audio* means that the sound card uses eight bits to digitize each sound sample. This translates into 256 possible digital values to which the sample can be pegged (less quality than the 65,536 values possible with a 16-bit sound card). Generally, 8-bit audio is adequate for recorded speech whereas 16-bit sound is best for the demands of music (see fig. 12.4).

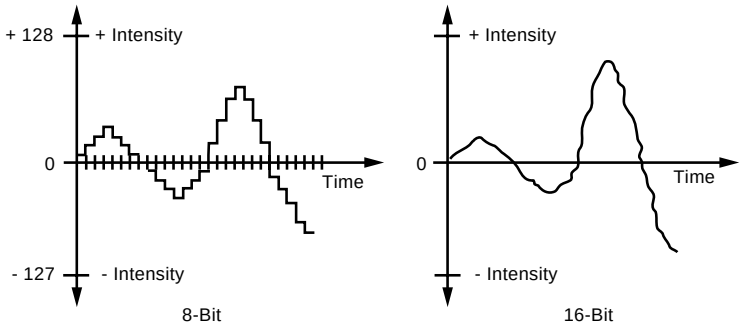

Fig. 12.4
16-bit resolution means more accurate sound reproduction than 8-bit resolution.

The Logitech AudioMan was designed as an 8-bit sound device with which business users could add voice notes to their Windows work. Likewise, Compaq Computer Corp.'s original Business Audio was 8-bit quality. (It has since been replaced by 16-bit Enhanced Business Audio.)

Whether you use 8-bit or 16-bit sound depends on which is more important to you: sound quality or disk space. The sampling frequency determines how often the sound card measures the level of the sound being recorded or played back. Basically, you have to sample at about two times the highest frequency you want to produce, plus an extra 10 percent to keep out unwanted signals.

Humans can hear up to 20,000 cycles per second, or 20 kHz. If you double this number and add 10 percent, you get a 44.1 kHz sampling rate, the same sampling rate used by high-fidelity audio CDs.

Sound recorded at 11 kHz (capturing 11,000 samples per second) is fuzzier than audio sampled at 22 kHz. A sound sampled in 16-bit stereo at 44 kHz (CD-audio quality) requires as much as *10.5M per minute* of disk space*!* The same sound sample in 8-bit mono at 11 kHz takes 1/16th the space. If you were to add a one-minute hi-fi voice annotation to your Excel spreadsheet, you'd find, when you finished recording, a spreadsheet whose size had at least quadrupled!

The CD-ROM Connection

Besides a sound card, the other foundation of multimedia is a CD-ROM (compact disc read-only memory) drive.

CD-ROM drives provide access to a wealth of text, graphics, sound, video, and animation. A single 4 3/4-inch compact disc can hold 660M of information. For example, a single CD-ROM can hold the equivalent information, along with pictures and sounds, of an encyclopedia set. Popping a CD-ROM into the drive is like piling 300,000 pages of information onto your bookshelves.

Many sound cards double as a CD-ROM controller, or interface card. Some sound cards, however, use a proprietary connection that accommodates only certain CD-ROM drives. For a wider selection of drives, consider a sound card that includes a SCSI (Small Computer Systems Interface) connector. By owning a SCSI sound card you can save both a slot in your PC and some money on a drive.

All CD-ROM players read all standard CD-ROM discs, just as the CD player in your stereo plays any CD you find in a record store. There's only one caveat: if you eventually want to play CD-ROMs recorded in the extended architecture (XA) format, you may need to upgrade your interface card.

If you want to use multimedia, your CD-ROM drive must also have an extra audio connection to send sound in analog form from the drive to the sound card.

Like a hard drive, a CD-ROM drive is measured by two criteria: *average access speed* and *data transfer rate*. The average access speed is the length of time the CD-ROM drive takes to find the information you request. This speed is measured in milliseconds (ms), or thousandths of a second. The data transfer rate indicates how fast the found information can be sent to your PC. This rate is measured in kilobytes transferred per second (KBps).

Make sure that the CD-ROM drive you buy meets the MPC (Multimedia PC) specifications for performance. The MPC recipe has changed since its debut: a drive must be double-speed (capable of a sustained 300KBps data transfer rate), with an access time of 400ms or less. The CD-ROM drive must use no more than 60 percent of the CPU's resources during a 300KBps read, and no more than 40 percent at 150KBps throughput. A 64K onboard memory buffer and read-ahead buffering are recommended but not mandated.

Triple- and quadruple-speed (abbreviated 3X and 4X, respectively) CD-ROM drives are also available. Triple-speed drives provide a minimum data transfer rate of 450Kbps. At the time of this writing, the triple-speed drives provide the best balance of performance versus price. However, some manufacturers such as Panasonic, Philips, Pioneer, and Sony are developing quad- but not triple-speed units. When buying a drive, you may be able to trade buffer size for access time or vice versa. If you know you will be mostly using reference materials, such as a magazine text-based database on CD-ROM, then you would prefer a faster access time (under 200–300 ms) and triple or quadruple speed. If you will be accessing large sound files, you would instead prefer a larger buffer of 256K. If primarily accessing graphics, such as stock photos on CD, insist on both a large 256K buffer and triple or quadruple speed.

Sound File Formats

There are several file formats for storing and editing digitized sound. The most notable is the WAV format supported by Windows 3.1. (WAV is short for waveform audio.) One audio minute saved to a WAV file requires 2.5M of disk space.

There are two other types of PC audio: synthesized sound and MIDI music. Synthesized sounds, like synthetic foods, are artificially created. Sound cards typically use one or two FM (frequency modulation) chips, such as those provided by Yamaha, to generate mono or stereo sounds without consuming as much disk space as WAV sound files.

The serious musician may prefer a high-end sound card, such as MultiSound from Turtle Beach. The MultiSound uses digitized sounds of actual instruments. These sounds are preserved in special ROM (read-only memory) chips. Using this *wave-table synthesis* technique, the Multisound plays genuine strings and trumpets instead of synthesized music that imitates sounds like strings and trumpets.

MIDI is a step above synthesized sound. MIDI, the acronym for Musical Instrument Digital Interface, allows your computer to store, edit, and play back music through a MIDI instrument such as a keyboard synthesizer. MIDI is more like a networking programming language, allowing you to add more instruments, including drum machines and special sound effects generators.

The MPC specs insist on MIDI support, although not all of us are musicians. Budget-priced sound cards such as the Microsoft Sound System do not provide a MIDI interface.

Compression/Decompression

Since one minute of stereo audio can consume up to 11M of disc space, several sound card makers use Adaptive Differential Pulse Code Modulation (ADPCM) compression to reduce file size by over 50 percent. However, a simple fact of audio life is that when you use such compression, you lose sound quality.

Because the sound quality can be degraded, there is no ADPCM standard. Creative Labs uses a proprietary hardware approach, while Microsoft is pushing the Business Audio ADPCM design developed with Compaq.

One emerging compression standard is the Motion Pictures Experts Group (MPEG) standard, which works with both audio and video compression and is gaining support in the non-PC world from products like the Philips CD-I player. With a potential compression ratio of 12:1 and full-motion-video MPEG CD-ROM titles expected soon, this standard may catch on.

Sound Card Characteristics

What are some key features to consider in a sound card? Although some aspects are subjective, the following sections describe some key buying points.

Compatibility

Although there are no official sound card standards, the popular Sound Blaster card has become a de facto standard. The Sound Blaster—the first widely distributed sound card—is supported by the greatest number of software programs. A sound card advertised as Sound Blaster-compatible should run virtually any application that supports sound.

Many sound cards also support the Multimedia PC (MPC) Level 2 specifications, allowing you to play sound files in Windows and more. Some sound cards, by excluding a MIDI interface, barely fall short of the MPC specs. Other compatibility standards to look for are Ad Lib and Pro AudioSpectrum.

Sampling

The most important sound card quality is its sampling capability. The rate at which the card samples (measured in kilohertz, or kHz) and the size of its sample (expressed in bits) determine the quality of the sound. The standard sampling rates for sound cards are 11.025 kHz, 22.050 kHz, and 44.1 kHz; sample sizes are 8, 12, and 16 bits.

Inexpensive monophonic cards generally sample at 8 bits up to speeds of 22.050 kHz, which is fine for recording voice messages. Some stereo-capable cards sample at 8 bits and run at speeds of 22.050 kHz in stereo and up to 44.1 kHz in mono. Other cards can sample 8 bits at 44.1 kHz speeds in both stereo and mono. The latest generation of cards do it all; they can record CD-quality audio of 16 bits at 44. 1kHz.

Don't expect a higher-sampling sound card to provide better sound. Very few software programs currently support 16-bit sound. Most computer games, for example, use 8-bit samples. Even the best-selling Sound Blaster Pro supports recording at 8 bits only. If price is your primary concern, a basic 8-bit card may meet your needs although it won't meet the MPC Level 2 specifications.

If you do buy a card that supports 16-bit sampling, make sure you have plenty of hard disk space. The higher the resolution of sampling, the more hard disk space needed to store the file. The sampling rate also affects file size; sampling at the next higher rate doubles the file size.

Stereo versus Mono

You'll also have to consider buying a monophonic or stereophonic sound card. Inexpensive sound cards are monophonic, producing sound from a single source. Still, monophonic cards produce better sound than your PC's speaker.

Stereophonic cards produce many voices, or sounds, concurrently and from two different sources. The more voices a card has, the higher the sound fidelity. Each stereo chip in a sound card is capable of 11 or more voices. To get 20 or more voices, manufacturers had to resort to two FM synthesizer chips. Today, a single chip produces 20 voices, providing truer stereo sound.

The number of voices a stereo card has is especially important for music files because the voices correspond to the individual instruments the card can play.

Most sound cards use FM synthesis to imitate the musical instruments played. Most use synthesizer chips developed by Yamaha. The least expensive sound cards use the monophonic 11-voice YM3812 or OPL3 chip. Better sound cards use the stereophonic 20-voice YMF262 or OPL3 chip.

Imitated musical instruments are not as impressive as the real thing. High-end sound cards use digital recordings of real instruments and sound effects. Often, several megabytes of these sound clips are embedded in ROM chips on the card. For example, some sound cards use the Ensoniq chipset (a type of circuit design) that does wave-table synthesis of musical instruments. Instead of pretending to play a trombone D flat, the Ensoniq chipset has a little digitized recording of an actual instrument playing that note.

If your primary interest in a sound card is for entertainment or use in educational or business settings, FM synthesis quality may be good enough.

Stereo sound cards vary in sampling rates and sizes. Some stereo cards do not work in mono mode. Also, moving from mono to stereo sound means an increase in the size of the sound files. As with 16-bit resolution, stereo sound is not supported by most software applications. However, a stereo card playing mono software does generate better sound than a mono card.

Another boon to buying the more expensive stereo cards is that they generally come with additional interfaces, such as connections to a SCSI device (such as a CD-ROM drive) or a MIDI device (such as a keyboard).

CD-ROM Connector

Most stereo sound cards not only provide great sound but also can operate your CD-ROM drive. Although many cards come with a SCSI port for any SCSI device, such as a CD-ROM drive, others support only a proprietary CD-ROM interface, such as just Mitsumi or Sony CD-ROM interfaces. If you own a CD-ROM drive, make sure it's compatible with the sound card you plan to buy. If you plan to add a CD-ROM drive or if you expect to upgrade your drive, keep in mind that a proprietary interface will limit your choices, perhaps to a single CD-ROM brand.

If you're seeking to add both a sound card and a CD-ROM drive, consider *multimedia upgrade kits*. These kits bundle a sound card, CD-ROM drive, CD-ROM titles, software, and cables in an attractively priced package. By buying a multimedia upgrade kit rather than disparate components, you may save some money. And you'll know that the components will work together, especially if the kit includes proper documentation.

Data Compression

The more-expensive cards produce CD-quality audio, which is sampled at 44.1 kHz. At this rate, recorded files (even of your own voice) can consume as many as 11M for every minute of recording. To counter this demand for disk space, many sound cards include a data-compression capability. For example, the Sound Blaster ASP 16 includes on-the-fly compression of sound in ratios of 2:1, 3:1, or 4:1.

MIDI Interface

The Musical Instrument Digital Interface (MIDI) is a standard for connecting musical instruments to PCs. Many stereo cards come with a MIDI interface, MIDI synthesizer, and sequencing software for composing music. Some cards include only a MIDI interface; you have to purchase the hardware separately to hook up other MIDI devices. Other sound cards may exclude the MIDI interface.

Bundled Software

Sound cards usually include several sound utilities so that you can begin using your sound card right away. Most of this software is DOS-based, but Windows-based versions are available with some cards. The possibilities include:

- Text-to-speech conversion programs
- Programs for playing, editing, and recording audio files
- Sequencer software, which helps you compose music (generally included with cards with MIDI interfaces)
- Various sound clips

Multi-Purpose Digital Signal Processors

One recent addition to many sound boards is the digital signal processor (DSP). DSPs add intelligence to your sound card, freeing your computer from work-intensive tasks, such as filtering noise from recordings or compressing audio on the fly.

About half of most general-purpose sound cards use DSPs. The Cardinal Technologies Sound Pro 16 and Sound Pro 16 Plus, for example, use the Analog Devices ADSP2115 digital signal processor. The Sound Blaster AWE32's programmable DSP features compression algorithms for processing text-to-speech data and enables the card's QSound surround-sound 3-D audio, along with reverb and chorus effects. DSPs allow a sound card to be a multi-purpose device. IBM uses its DSP to add a 14.4-kilobit-per-second modem, 9.6KBps fax, and a digital answering machine to its WindSurfer Communications Adapter.

Are DSPs worth the extra price? On low-powered PCs (those less powerful than a 486SX/25) or in true multitasking environments like Windows 3.1 or Windows NT, a DSP can make real-time compression possible—a valuable feature for voice annotation.

Sound Drivers

Most sound cards include universal drivers for DOS and Windows applications. Find out which drivers are included with your card. Windows 3.1 already includes drivers for the most popular sound cards, such as Sound Blaster. Other drivers are available on a separate driver disk available from Microsoft or from Microsoft's Product Support download service.

Connectors

Most sound cards have the same connectors. These 1/8-inch minijack connectors provide ways to pass sound from the sound card to speakers, headphones, and stereo systems; and to receive sound from a microphone, CD player, tape player, or stereo. The four types of connectors your sound card typically could or should have are shown in figure 12.5.

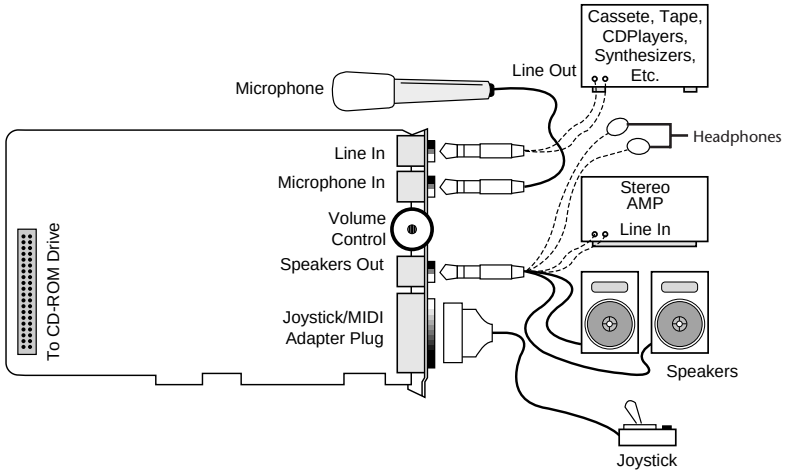

Fig. 12.5

The basic features most sound cards have in common.

- *Stereo line, or audio, out connector.* The line out is used to send sound signals from the sound card to a device outside the computer. The cables from the line out connector can be hooked up to stereo speakers, a headphone set, or your stereo system. If you hook up your stereo system, you can have amplified sound. Some sound cards, such as the Microsoft Windows Sound System, provide two jacks for line out. One is for the left channel of the stereo signal; the other is for the right channel.
- *Stereo line, or audio, in connector.* The line in connector is used to record, or mix, sound signals to the computer's hard disk.
- *Speaker/headphone connector.* The speaker/headphone connector is not always provided on a sound card. Instead, the line out (described earlier) doubles as a way to send stereo signals from the sound card to your stereo system or speakers. When both speaker/headphone and line out connectors are provided, the speaker/headphone connector provides an amplified signal that can power your headphones or small bookshelf speakers. Most sound cards can provide up to 4 watts of power to drive your speakers. Conversely, signals sent through the line out connector are not amplified. Using the line-out connector provides the best sound reproduction since the stereo system or amplified speakers will amplify the sounds.

- *Microphone, or mono, in connector*. You connect a microphone to this 1/8-inch minijack to record your voice or other sounds to disk. This microphone jack records in mono, not in stereo. Many sound cards use Automatic Gain Control (AGC) to improve recordings. This feature adjusts the recording levels on the fly. A 600 to 10K ohm dynamic or condenser microphone works best with this jack. Some inexpensive sound cards use the line in connector instead of a separate microphone jack.
- *Joystick/MIDI connector*. The joystick connector is a 15-pin, D-shaped connector. Two of the pins are used to control a MIDI device, such as a keyboard. Many sound card makers offer an optional MIDI connector.

Sometimes the joystick port can accommodate two joysticks if you order the optional Y-adapter. To use this connector as a MIDI interface, you'll need to buy the optional MIDI cable. Some sound cards do not provide a MIDI interface. If you're not interested in making music (and spending a few hundred dollars more for the MIDI keyboard), you may want to consider these models. And don't worry about the lack of a joystick port. Most PCs include one as part of the input/output (I/O) card; otherwise, you can buy a separate game card, such as the GameCard III Automatic from CH Products.

Volume Control

A thumbwheel control is provided on some sound cards, although sophisticated sound cards have no room for such a control. Instead, a combination of keys can be used to adjust the sound. Media Vision's Pro AudioStudio 16, for example, uses Ctrl-Alt-U to increase the volume and Ctrl-Alt-D to decrease it. By pressing these key combinations you adjust the volume from within a game, Windows program, or any other application.

Sound Card Options

You'll seldom buy just a sound card. You'll need—or want—other accessories that raise the cost of your PC sound system. At the very least, you'll have to invest in a set of speakers or headphones. At most, you may want to purchase a MIDI synthesizer keyboard.

Speakers

Successful business presentations, multimedia applications, and MIDI work demand external high-fidelity stereo speakers. Although you can use standard stereo speakers, they are too big to fit on or near your desk. Smaller bookshelf speakers are better.

Sound cards offer little or no power to drive external speakers. Although some sound cards have small 4-watt amplifiers, they are not powerful enough to drive quality speakers. Also, conventional speakers sitting near your display may create magnetic interference, which can distort colors and objects on-screen or jumble the data recorded on your nearby floppy disks.

To solve these problems, computer speakers need to be small, efficient, and self-powered. Also, you need to provide magnetic shielding, either in the form of added layers of insulation in the speaker cabinet or by electronically canceling out the magnetic distortion.

Note

Although most computer speakers are magnetically shielded, do not leave recorded tapes, watches, personal credit cards, or floppy disks in front of the speakers for long periods of time.

Quality sound depends on quality speakers. A 16-bit sound card may provide better sound to computer speakers, but even an 8-bit sound card sounds good from a good speaker. Conversely, an inexpensive speaker makes both 8-bit and 16-bit sound cards sound tinny.

The dozens of models on the market range from less expensive minispeakers from Sony and Koss to larger self-powered models from companies such as Bose. To evaluate speakers, you need to know the lingo. Speakers are measured by three criteria:

- *Frequency response.* A measurement of the range of high and low sounds a speaker can reproduce. The ideal range is from 20 Hz to 20 kHz, the range of human hearing. No speaker system reproduces this range perfectly. In fact, few people hear sounds above 18 kHz. An exceptional speaker may cover a range of 30 Hz to 23,000 kHz. Lesser models may cover only 100 Hz to 20,000 Hz. Frequency response is the most deceptive specification, because identically rated speakers can sound completely different.
- *Total Harmonic Distortion (THD).* THD, or just *distortion*, is an expression of the amount of distortion or noise created by amplifying the signal. Simply put, distortion is the difference between the sound sent to the speaker and the sound we hear. The amount of distortion is measured in percentages. An acceptable level of distortion is that below .1 percent (one-tenth of one percent). For some CD-quality recording equipment, a common standard is .05 percent. Some speakers have a distortion of 10 percent or more. Headphones often have a distortion of about 2 percent or less.
- *Watts.* Usually stated as *watts per channel*, this is the amount of amplification available to drive the speakers. Check that the company means "per channel" (or RMS) and not total power. Many sound cards have built-in amplifiers, providing up to 8 watts per channel. (Most provide 4 watts.) The wattage is not enough to provide rich sound, however, which is why many speakers have built-in amplifiers. With the flick of a switch or the press of a button, such speakers amplify the signals they receive from the sound card. If you do not want to amplify the sound, you typically leave the speaker switch set to "direct." In most cases, you'll want to amplify the signal.

Two or four C batteries are often used to power computer speakers. Because these speakers require so much power, you may want to invest in an AC adapter, although more expensive speakers include one. With an AC adapter, you won't have to buy new batteries every few weeks. If your speakers didn't come with an AC adapter, you can pick one up from your local Radio Shack or hardware store.

You can control your speakers in various ways, depending on their complexity and cost. Typically, each speaker has a volume knob, although some share one volume control. If one speaker is farther away than the other, you may want to adjust the volume accordingly. Many computer speakers include a dynamic bass boost (DBB) switch. This button provides a more powerful bass and clearer treble, regardless of the volume setting. Other speakers have separate bass and treble boost switches or a three-band equalizer to control low, middle, and high frequencies. When you rely on your sound card's power rather than your speaker's built-in amplifier, the volume and dynamic bass boost controls have no effect. Your speakers are at the mercy of the sound card's power.

A 1/8-inch stereo minijack connects from the sound card output jack to one of the speakers. The signal is then split and fed through a separate cable from the first speaker to the second one.

Before purchasing a set of speakers, check that the cables between the speakers are long enough for your computer setup. For example, a tower case sitting alongside one's desk may require longer speaker wires than a desktop computer.

Beware of speakers that have a tardy built-in "sleep" feature. Such speakers, which save electricity by turning themselves off when they are not in use, may have the annoying habit of clipping the first part of a sound after a period of inactivity.

Headphones are an option when you can't afford a premium set of speakers. Headphones provide privacy and allow you to play your sound card as loud as you like.

Microphone

Most sound cards do not include a microphone. You'll need one to record your voice to a WAV file. Selecting a microphone is quite simple. You need one that has a 1/8-inch minijack to plug into your sound card's microphone, or audio in, jack. Most have an on/off switch.

Like speakers, microphones are measured by their frequency range. This is not an important buying factor, however, since the human voice has a limited range. If you are recording only voices, consider an inexpensive microphone that covers a limited range of frequencies. An expensive microphone's recording capabilities extend to frequencies outside the voice's range. Why pay for something you won't be needing?

If you are recording music, invest in an expensive microphone, although an 8-bit sound card can record music just as well with an inexpensive microphone as an expensive one.

Your biggest decision is to select a microphone that suits your recording style. If you work in a noisy office, you may want a unidirectional microphone that will prevent extraneous noises from being recorded. An omnidirectional mike is best for recording a group conversation. If you want to leave your hands free, you may want to shun the traditional hand-held microphone for a lapel model.

Some sound cards include a microphone. For example, the Media Vision Pro AudioStudio 16 includes a small lapel microphone and a holster in which to place it. The Sound Blaster 16 ASP includes a hand-held microphone.

Joysticks

Many sound cards include a joystick, or game, port. (This joystick port often doubles as a connection to a MIDI device.) A joystick is ideally meant for game playing, such as simulating flying a Cessna aircraft. Joysticks, like speakers, are best chosen through hands-on experience.

A joystick has a fire button on top of a center wand you move in any of eight directions, with a second button or pair of buttons located on the base.

Good joysticks have resistance that increases the further you move the center wand from dead center. Some joysticks include suction cups that mount the unit on your desk. If you're short on desk space, you may prefer a smaller joystick that fits in your hand. If you are left-handed, look for an ambidextrous joystick, not one that is contoured for right-handers.

Some joysticks are meant especially for flight-simulation games. The ThrustMaster, from ThrustMaster Inc., provides additional buttons for firing and selecting missiles, turning radar on or off, and looking in different directions.

MIDI Connector

If you are interested in MIDI to create synthesized music, you'll need to connect your musical keyboard or other MIDI device to your sound card. The joystick port on sound cards has unused pins that can be used to send and receive MIDI data. By connecting a MIDI interface cable to the joystick port, you can connect your PC to a MIDI device. The cable has three connectors: a joystick connector, and MIDI In and Out connectors.

Media Vision sells an adapter box called MIDI Mate ($69.95) for adding Musical Instrument Digital Interface input, output, and throughput connectors to its boards. The Pro AudioSpectrum boards use a SCSI interface.

Creative Labs furnishes its MIDI Kit for its Sound Blaster family of sound cards. This kit includes a Voyetra Technologies sequencer program to record, edit, and play back your MIDI files, as well as an interface cable to attach your sound card to the keyboard.

Synthesizer

If you are considering MIDI, you will also have to get a MIDI keyboard synthesizer. To make MIDI scores, you need sequencer software to record, edit, and play back MIDI files. (Some sound cards include sequencing software.) You also need a sound synthesizer, which is included in the sound card. A MIDI keyboard simplifies the creation of musical scores. A MIDI file contains up to 16 channels of music data, so you can record many different instruments and play them back. Using the keyboard, you can enter the notes for various instruments.

To enhance MIDI sounds for the Sound Blaster 16 ASP sound card, consider the $249.95 Wave Blaster from Creative Labs. The Wave Blaster attaches to the Sound Blaster ASP 16. When MIDI music is played, it looks to the Wave Blaster for any of 213 CD-quality digitally recorded musical instrument sounds. Without the Wave Blaster, the Sound Blaster 16 ASP would imitate these sounds through FM synthesis. With the Wave Blaster, music sounds as though it's being played by real instruments—because it is.

Several MIDI keyboards are available, such as the Roland A-30 or PC-200 MK2. These keyboards range in price from $395 to more than $7,000.

Sound Card Installation

Installing a sound card is no more intimidating than installing an internal modem or a VGA card.

Typically, you follow these steps to install a sound card:

1. Open your computer.
2. Configure your sound card.
3. Install the sound card and attach the CD-ROM drive, if present.
4. Close your computer.
5. Install the sound card software.
6. Attach your speakers and other sound accessories.

Note

Some manufacturers use a different installation order than this. Microsoft Corporation's Windows Sound System has you install the software first to determine how it can best work in your PC.

Once your computer is open, you can install the sound card. Your sound card may be either an 8-bit or 16-bit expansion card. Select a slot that matches the type of card you have. You don't want to put a 16-bit card (one with dual edge connectors) into an 8-bit slot (one with a single edge connector). An 8-bit card, however, can fit in either an 8-bit or 16-bit slot.

If you have several empty slots from which to choose, you may want to place the new card in one as far away as possible from the others. This reduces any possible electromagnetic interference; that is, it reduces stray radio signals from one card that might affect the sound card.

Next, you must remove the screw that holds the metal cover over the empty expansion slot you've chosen. Remove your sound card from its protective packaging. When you open this bag, carefully grab the card by its metal bracket and edges. *Do not touch any of the components on the card*. Any static electricity you may transmit can damage the card. And do not touch the gold edge connectors. You may want to invest in a grounding wrist strap, which continually drains you of static build-up as you work on your computer.

You may have to set jumpers or DIP switches to configure your sound card to work best with your computer. For example, you may want to turn off your sound card's joystick port because your joystick is already connected elsewhere to your PC. See the instructions that came with your sound card.

If an internal CD-ROM drive is to be connected to the sound card, attach its cables. Attach your CD-ROM's striped ribbon cable to your sound card, placing the red edge of the CD-ROM cable on the side of the connector on which "0" or "1" printed. The cable must be placed this way for the CD-ROM drive to work.

The CD-ROM drive may also have an audio cable. Connect this cable to the audio connector on the sound card. This connector is keyed so that you can't insert it improperly.

Next, insert the card in the edge connector. First touch a metal object, such as the inside of the computer's cover, to drain yourself of static electricity. Then, holding the card by its metal bracket and edges, place it in the expansion slot. Attach the screw to hold the expansion card and then reassemble your computer.

You can connect small speakers to the speaker jack. Typically, sound cards provide four watts of power per channel to drive bookshelf speakers. If you are using speakers rated for less than four watts, do not turn up the volume on your sound card to the maximum; your speakers may burn out from the overload. You'll get better results if you plug your sound card into powered speakers, that is, speakers with built-in amplifiers.

Another alternative is to patch your sound card into your stereo system for greatly amplified sound. Check the plugs and jacks at both ends of the connection. Most stereos use pin plugs—also called RCA or phono plugs—for input. Although pin plugs are standard on some sound cards, most use miniature 1/8-inch phono plugs, which require an adapter when connecting to your stereo system. From Radio Shack, for example, you can purchase an audio cable that provides a stereo 1/8-inch miniplug on one end and a phono plug on the other (Cat. No. 42-2481A).

Make sure that you get stereo, not mono, plugs, unless your sound card supports mono only. To ensure that you have enough cable to reach from the back of your PC to your stereo system, get a six-foot long cable.

Hooking up your stereo to a sound card is simply a matter of sliding the plugs into jacks. If your sound card gives you a choice of outputs—speaker/headphone and stereo line out—choose the stereo line out jack for the connection. Choosing it will give you the best sound quality because the signals from the stereo line out jack are not amplified. The amplification is best left to your stereo system.

Connect this output to the auxiliary input of your stereo receiver, preamp, or integrated amplifier. If your stereo doesn't have an auxiliary input, other input options include—in order of preference—tuner, CD, or Tape 2. (Do not use phono inputs, however, because the level of the signals will be uneven.) You can connect the cable's single stereo miniplug to the sound card's Stereo Line Out jack, for example, and then connect the two RCA phono plugs to the stereo's Tape/VCR 2 Playback jacks.

The first time you use your sound card with a stereo system, turn down the volume on your receiver to prevent blown speakers. Barely turn up the volume control and then select the proper input (such as Tape/VCR 2) on your stereo receiver. Finally, start your PC. Never increase the volume to more than three-fourths of the way up. Any higher and the sound may become distorted.

Troubleshooting Sound Card Problems

To install a sound card, you need to select IRQ numbers, a base I/O address, or DMA channels that don't conflict with other devices. Most cards come already configured to use an otherwise idle set of ports, but problems occasionally arise. Troubleshooting may mean that you have to change board jumpers or switches, or even reconfigure your other cards. No one said life was fair.

Hardware Conflicts

The most common problem for sound cards is that they fight with other devices installed in your PC. You may notice that your sound card simply doesn't work, repeats the same sounds over and over, or causes your PC to freeze in Windows or DOS. This situation is called a *device*, or *hardware, conflict*. What are they fighting over? The same signal lines or channels used for talking to your PC. The sources of conflict are threefold:

- *Interrupt requests (IRQs)*. IRQs are used to "interrupt" your PC and get its attention.
- *Direct memory access (DMA) channels*. DMA channels are the way to move information directly to your PC's memory, bypassing your PC's central brain. DMA channels allow sound to play while your PC is doing other work.
- *Input/output (I/O) addresses*. An I/O address in your PC is used to channel information between your sound card and your PC. The address usually mentioned in a sound card manual is the starting address. Actually, your sound card may require several addresses, which together are called an *address segment*.

Your potential for problems is doubled or tripled because the Sound Blaster-compatible sound cards, and MIDI portions of many sound cards generally, also use an IRQ, DMA, and I/O address. For example, the Pro AudioStudio 16 by default uses DMA 5 and IRQ 7 for its "native" mode and DMA 1 and IRQ 5 for Sound Blaster compatibility. Also, you can have separate DMA and IRQ settings when your sound card is used with Windows.

Most sound cards include installation software that analyzes your PC and attempts to find settings that are not yet assigned to other devices. Although fairly reliable, this analysis is not complete because unless a device is operating during the analysis, detecting it is not always possible.

Resolving Interrupt Problems. Your sound card may support any of several interrupts, or IRQs (see table 12.1). Many of the 16 IRQs are reserved for parts of your PC, such as the keyboard (IRQ2). Some sound cards only work with certain IRQs. For example, the Windows Sound System supports IRQs 7, 9, 10, and 11 (the default), whereas the Logitech SoundMan 16 uses 2, 3, 5, 7, 10, 11, 12, or 15. The primary symptom of an interrupt conflict is that a sound skips, playing continuously.

Table 12.1 Interrupts and What They Control

Interrupt	Device	Comments
0	Timer	
1	Keyboard	
2	Unused	Used in AT-type computers as a gateway to IRQ 8/15 or for EGA/VGA video cards.
3	COM2 (second serial port)	Used for a modem or mouse.
4	COM1 (first serial port)	Used for a modem or mouse.
5	Hard disk	XT-type computers only; otherwise available for AT-type computers to use.
6	FDC (floppy disk drive controller)	
7	LPT1 (first parallel printer port)	
8	Clock	Interrupts 8 through 15 are available on AT-type computers only and often not to expansion cards.
9	PC network	
10–12	Unused	
13	Math coprocessor	Used for speeding mathematical calculations, such as those used in spreadsheet or computer-aided design (CAD) programs.
14	Hard disk	
15	Unused	

Correct DMA Channels. Your sound card also supports several DMA channels (see table 12.2). Many of the eight DMAs are reserved for parts of your PC, such as your floppy disk controller (DMA 2). DMA channels 5, 6, and 7 are used to provide the best performance under Windows. The primary symptom of a DMA conflict is that you hear no sound at all.

Table 12.2 DMA Channels and Their Purposes

DMA Channel	Purpose
0	Unused
1	Often reserved for Sound Blaster compatibility
2	Used by floppy disk controller
3	Unused
4	Refreshes computer's memory
5	Unused
6	Unused
7	Unused

Solving Hardware Conflicts. The best way to find a hardware conflict is to locate all of the documentation for your PC and its various devices, such as a tape backup interface card, CD-ROM drive, etc. Complete the list shown in table 12.3, adding the DMA, IRQ, and I/O address used by each device. By deduction and the following procedure, you can find which device is causing the problem.

Table 12.3 Hardware Conflict Worksheet

Device	DMA	IRQ	I/O Address
Timer	NA	0	
Keyboard	NA	1	
COM1	NA	4	
COM2	NA	3	
LPT1	NA	7	
Memory refresh	4	NA	
Floppy disk	2	6	
Hard disk	NA	14	
Math coprocessor	NA	13	
PC network	NA	9	
EGA/VGA card	NA	2	

Following are the most common causes of hardware conflicts:

- Network interface cards
- Tape drive interface cards
- Special printer controllers (such as a PostScript controllers)
- SCSI or other device controllers
- Modems and other serial devices
- Scanner interface cards

How do you find which device is conflicting with your sound card? Temporarily remove all of your expansion cards except the sound card and other essential cards (such as the video card). Then add each of the cards you removed, one at a time, until your sound card no longer works. The last card you added is the troublemaker.

Having found the card that's causing the conflict, you can either switch the settings for the device that is conflicting with your sound card or change the settings of the sound card. In either case, you will have to change the IRQ, DMA, or I/O address. To do this, you must set jumpers or DIP switches or use your sound card's setup software to change its settings.

Other Sound Card Problems

Sound card problems (like the common cold) have common symptoms. Use the following sections to diagnose your problem.

No Sound. If you don't hear anything from your sound card, consider these solutions:

- Are the speakers connected? Check that the speakers are plugged into the sound card's Stereo Line Out or Speaker jack.
- If you're using amplified speakers, are they powered on? Check the strength of the batteries or the adapter's connection to the electrical outlet.

  I once owned a pair of Sony amplified speakers. An avid computer game player, I needed a new set of batteries every week. The first time, I was surprised when I couldn't hear any sound. The batteries were so drained that they could not drive the speaker.

- Are the speakers stereo? Check that the plug inserted into the jack is a stereo plug, not mono.
- Are mixer settings high enough? Many sound cards include a mixer control for DOS and/or Microsoft Windows. The mixer controls the settings for various sound devices, such as a microphone or CD player. There may be controls for both recording and playback. Increase the master volume or speaker volume when you are in the play mode. In DOS, you can adjust the setting by either modifying your CONFIG.SYS file or pressing keys.

- Use your sound card's setup or diagnostic software to test and adjust the volume of the sound card. Such software usually includes sample sounds that play. For example, the Sound Blaster 16 ASP includes TESTSB16.
- Turn off your computer for one minute and then turn it back on. Such a hard reset (as opposed to pressing the reset button or pressing Ctrl-Alt-Del) may clear the problem.
- If your computer game lacks sound, check that it works with your sound card. For example, some games may require the exact settings of IRQ 7, DMA 1, and address 220 to be Sound Blaster compatible.

One-Sided Sound. If you hear sound coming from only one speaker, check out these possible causes:

- Are you using a mono plug in the stereo jack? A common mistake is to place a mono plug into the sound card's speaker or stereo out jacks. Seen from the side, a stereo connector has two darker stripes. A mono connector has only one stripe.
- Is the driver loaded? Some sound cards provide only left-channel sound if the driver is not loaded in the CONFIG.SYS file. Again, run your sound card's setup software.

Volume Is Low. If you can barely hear your sound card, try these solutions:

- Are the mixer settings too low? Again, adjust the volume level in your DOS or Windows mixer. If your sound card uses keystrokes to adjust the volume, use them.
- Is the initial volume too low? Some sound cards provide volume settings as part of the line in CONFIG.SYS that loads the sound card driver. The number for the volume may be set too low.
- Are the speakers too weak? Some speakers may need more power than your sound card can produce. Try other speakers or put a stereo amplifier between your sound card and speakers.

Scratchy Sound. If the sound is scratchy, consider the following possible problems:

- Is your sound card near other expansion cards? The sound card may be picking up electrical interference from other expansion cards inside the PC. Move the sound card to an expansion slot as far away as possible from other cards.
- Are your speakers too close to your monitor? The speakers may pick up electrical noise from your monitor. Move them farther away.

Your Computer Won't Start. If your computer won't start at all, you may not have inserted the sound card completely into its slot. Turn off the PC and then press firmly on the card until it is seated correctly.

Parity Error or Other Lockups. Your computer may display a memory parity error message or simply "crash." Several causes are possible:

- Is there a DMA conflict? When your computer crashes, the crash is most likely caused by the sound card using the same DMA channel as another device, such as a disk, tape drive, or scanner. Use your sound card setup software to change the DMA channel.
- Is there an I/O address conflict? Another card may be using some of the I/O addresses used by your sound card. Try to remove some of the other cards to see if that resolves the conflict. If so, change the address of either the offending card or your sound card.
- Are you using certain DMA channels? Some sound cards work better with 16-bit DMA channels, such as 5, 6, or 7. Some computers, however, don't work well with these. Try using DMA 3, if available.
- Are you using DMA 1 for Sound Blaster compatibility? Many games require Sound Blaster compatibility set to DMA 1. This may cause conflicts with other cards. Try to change the other boards, unless you can set the game to another DMA.
- Should you try another Sound Blaster I/O port? You can change the I/O address required for Sound Blaster compatibility. The default setting is 220. But be sure to check that your game can accept a different value.

Joystick Won't Work. If your joystick won't work, consider the following list of cures:

- Are you using two game ports? If you already have a game port installed in your PC, the joystick port provided on your sound card may conflict with it. To resolve this conflict, disable the joystick port on your sound card or the one already in your PC. On the Logitech SoundMan 16 and Pro AudioStudio 16 sound cards, the joystick can be turned on or off with a simple change to the device driver line in CONFIG.SYS. For example, this line is for the Pro AudioStudio 16:

  ```
  DEVICE=C:\PASTUDIO\MVSOUND.SYS D:5 Q:7 S:1,220,1,5 M:1,330,2 J:0
  ```

  The last switch (J:0) is used to turn the joystick on or off. On is J:1, off is J:0. If you have a separate game card or joystick port, change this setting to J:0.
- Is your computer too fast? Some fast computers get confused by the inexpensive game ports. During the heat of battle, for example, you may find yourself flying upside down or spiraling out of control. This is one sign that your game port is inadequate. A dedicated game card, such as the CH Products GameCard III, can work with faster computers. Such game cards include software to calibrate your joystick and dual ports so that you can enjoy a game with a friend. Another solution is to run your computer at a slower speed, which is usually done by pressing some type of turbo button on your PC.

Unsolvable Problems. Unfortunately, some sound card problems cannot be solved. Your PC may be of a certain design that your sound card cannot support. For example, I initially could not get the Windows Sound System to work in my PC. It worked, but it either played the WAV files at "chipmunk" speed or with quality fit for the garbage disposal. A call to Microsoft's technical support staff helped to decipher the problem. The Windows Sound System was not tested with a PC that uses the Symphony chipset, a type of motherboard design. Apparently, this chipset handles the DMA channel differently than other motherboard designs. The solution was to wait for new software drivers and manually edit the SYSTEM.INI file.

Another solution to some sound card problems resides in the BIOS. In the AMI BIOS setup program the choice for the Timing Parameter Selection was set to 1, the best-case value. Somehow, this value affects the DMA timing. After the value is changed to 0, some sound cards work properly.

My main point here is that you shouldn't be frustrated if your sound card doesn't work. The PC "standard" is based loosely on the cooperation among a handful of companies. Something as simple as one vendor's BIOS or motherboard design can make the standard nonstandard.

Summary

This chapter introduced you to the uses of sound cards, including games, voice annotation, MIDI music-making, and voice recognition. The various facets of a sound card were discussed, such as the nature of sound, analog-to-digital (ADC) and digital-to-analog (DAC) conversion, and sampling. The chapter discussed the differences between 8- and 16-bit sound and how sound cards can double as CD-ROM interfaces. Sound standards such as Sound Blaster and AdLib were discussed as well as various sound file formats, such as WAV (waveform audio), FM and wave-table synthesis, and MIDI.

The chapter discussed the buying criteria for a sound card, such as bundled software, available driver, stereophonic versus monophonic cards, and connectors. Options were discussed, including speakers, MIDI keyboard synthesizers, joysticks and microphones. Finally, the chapter discussed installing a sound card and troubleshooting installation pitfalls. Most problems result from hardware conflicts involving DMA (direct memory access) channels, IRQs (interrupt request lines) and I/O addresses.