Use Your PC to Build an Incredible Home Theater System

BART FARKAS AND JEFF GOVIER

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CHAPTER 2

Home Theater PC Uses

THIS CHAPTER WILL answer the question, "Why should my DVD player be an HTPC?" To the computer hobbyist, this question needs no answer: Building a machine to play movies is much more fun than just purchasing one. For the rest of us, however, this question needs to be answered to provide some justification for investing time and money to create a machine that on the surface looks like it could easily be replaced by a low-cost DVD player. Of course, there is a lot more to an HTPC than just playing DVD movies, but since DVD technology represents the state-of-the-art for home theater, it is an ideal topic for comparing an HTPC to the alternatives and showing how the HTPC has many advantages over conventional DVD players.

Under the best conditions, an HTPC can provide better picture and sound than an off-the-shelf consumer DVD player. With the imminent arrival of high-definition television (HDTV), many people are already considering (or have made) the purchase of a new, larger television that is capable of displaying HDTV formats. In order to get the best possible high-resolution picture quality on an HDTV, many home theater enthusiasts use a *line-doubler* to increase resolution. These devices are available in a range of quality and prices, but an HTPC can output a comparable or better quality video picture for less money.

The output from an HTPC is much more adjustable than that from a dedicated DVD player, and in addition to precise adjustments to color levels and saturation, the HTPC allows for a variety of ways to convert the 24 frames per second (fps) of film to the 30 fps of television and to scale up the image for high-quality monitors. On a small display, this conversion is hardly noticeable, but on larger displays it becomes a much-discussed and debated issue. Even those home theater systems that include only a standard NTSC-capable television can benefit from the picture quality fine-tuning that can be accomplished with an HTPC (see Figure 2-1).

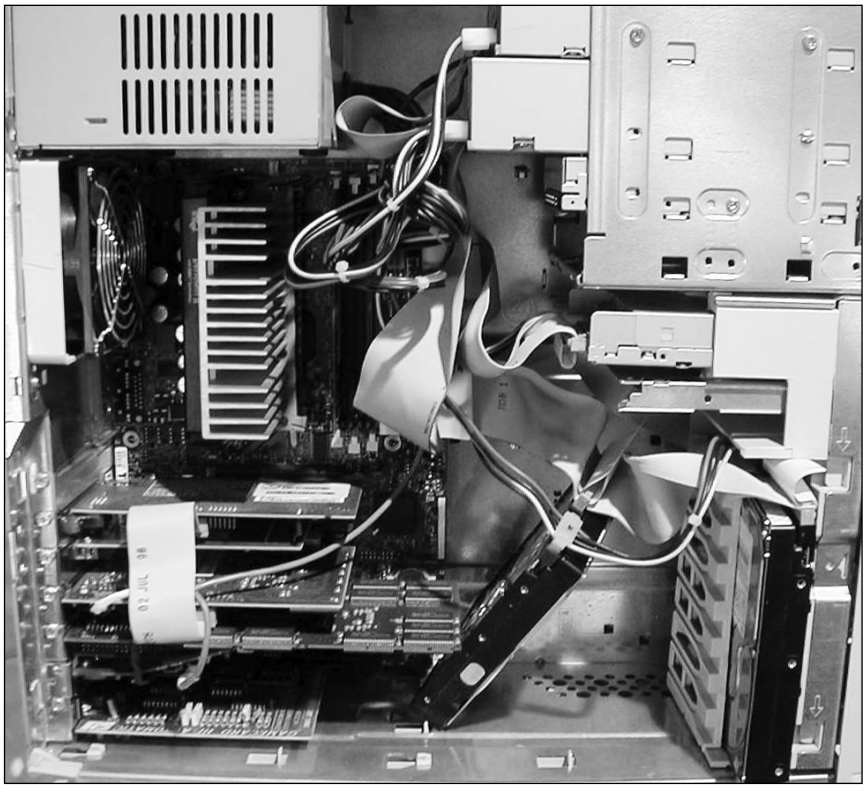

Figure 2-1. The HTPC looks like any other PC, but when configured properly it can make all *the difference.*

Improving Picture Quality

Standard television picture quality is quite poor compared to the newest movie and digital television formats. The NTSC television format specifies 525 lines of resolution at 60 fields per second, which is composed of 30 interlaced frames per second. On a standard direct-view television tube, this looks acceptable, but when the picture is bigger, the interlaced scan lines are visible. The NTSC television format was never meant for the large screen displays that are becoming popular today—after all, the NTSC standard was developed in 1953!

NOTE Progressive scan *means that all the lines on the monitor are being painted at the same time. This is different from* interlaced *pictures, where the scan lines are painted every second row.*

On a 36-inch or larger display, you can see the scan lines plainly from even an average 6-foot viewing distance. To counter this problem, newer television formats either increase the resolution or up-convert it to a progressively scanned picture. High-definition digital television uses progressive scan for all resolutions below 960 lines. Computer monitors can switch between interlaced and progressive modes, but consumer television sets do not switch. It is very easy to tell the difference between an interlaced picture and a progressive scan picture when comparing large television sets side by side in a store, and most people who can afford to do so prefer to buy the progressive scan set.

Converting Interlaced Video to Progressive Scan

Converting the NTSC interlaced picture to a progressive scan picture is not simple, and this is why the HTPC is a great tool for this problem. Remember that an interlaced picture shows half the picture lines each time it draws the screen. Even though the next set of lines follows right away, moving objects on the screen will not be in exactly the same spot as they were when the previous set of lines was displayed. The two sets of lines that make up the interlaced picture are not simply two halves of the same frame; they are each half of a separate frame (though NTSC is still referred to as 30 fps). Converting interlaced television pictures to progressive scan pictures cannot be done properly by simply drawing both sets of lines at the same time. The edges of moving objects look distorted by "stair steps," and fine detail will appear to flicker and vibrate.

A better method of converting interlaced to progressive scan is to double each interlaced line. This creates a full resolution picture for every field by repeating each line in the field, which means that the field becomes a full frame of information. The new frame does not have as much information as the combined interlaced frame, since it is made from half the lines of the full interlaced frame, but it has no motion-induced distortion. Thus, the resulting video signal has lower resolution and a higher frame rate.

These two methods of converting interlaced video to progressive scan video are called *line doubling*. A high-quality line-doubler also does some extra processing to eliminate motion distortion or increase resolution, depending on which method is used to convert the video signal. Though the resulting video quality is better than the original interlaced video, it is never as good as a native progressive scan signal. Though most high-quality progressive-scan televisions up-convert interlaced video to progressive scan, an HTPC can perform this function with more options to fine-tune and configure the video quality.

Image Scaling

Converting the resolution of a standard NTSC video signal to a high-resolution display device is almost as complicated as the interlaced to progressive scan conversion. Some display projectors require an up-conversion, though this is not usually needed, since almost all HDTV-ready televisions sold today will display NTSC just fine. However, many digital projectors and LCD or plasma displays have a *native resolution*. This is the resolution that the set was manufactured to display, and all other resolutions are either converted or not displayed at all. Therefore, in some cases it is desirable to convert the resolution, and doing so requires complicated digital processing.

NOTE *Although the NTSC video standard is 525 lines, only about 480 of those lines are visible to the viewer. The rest are used to synchronize the display to the signal and carry the closed captioning information.*

If the picture resolution is not converted to a simple multiple of the native format (i.e., 480 lines converted to 960 lines), then some lines are converted unevenly to the new resolution. Converting 480 lines to 540 lines means that every eighth line is repeated. This would make the resulting image look pretty odd, so instead of just doubling some interval of lines, a good converter will average the information on each line and use that information to draw the new lines. Such a video converter is called an *image scaler* and is quite costly. Low-quality scalers start above $700.00, and prices go up to $20,000.00 for high-quality units.

The HTPC Advantage

The HTPC will do the interlaced-to-progressive-scan conversion and video scaling at a high quality for considerably less cost than an external scaler. Using an HTPC to output to a high-definition display device is a great solution to the prohibitive costs of an image scaler. The HTPC can be set to the best image resolution that the display can handle—such as 720p or 1080i for an HDTV—and it will convert everything else up to that quality. Even DVD movies, which are encoded at 480p, can be displayed at HDTV resolution.

TIP *Scaling an NTSC (480i) or DVD (480p) video image to 1080i does not make it as good as a native 1080i video image. The original video signal does not gain extra information—the extra lines in the high-definition image are just filled in with detail from the original lines. The only advantage to scaling an image up is to keep the display at its native resolution. It may also be convenient to leave the television set at one display resolution setting and use the HTPC to switch between video sources with different resolutions.*

Many DVD movies are presented with an *anamorphic picture.* This means that the picture is not the same shape as a standard television screen, which has a ratio of width to height of 4:3. An anamorphic picture is usually wider than a standard television, and these wide-screen movies are meant for wide-screen televisions. When an anamorphic movie is shown on a 4:3 television, black space is visible above and below the picture. Some viewers find this distracting, and even an HTPC cannot do much to alleviate it. However, the anamorphic movie shown on a 4:3 television has another problem, and most home theater enthusiasts consider it a much bigger problem than the black bars: resolution loss. Since the movie picture is squeezed down to fit into the display area, it loses resolution. To put it another way, those black bars above and below the picture are using up lines of resolution that the picture in the middle of the screen should use. The effects of this are subtle, but disturbing to those who are fussy about picture quality.

The simple solution is to use a wide-screen television to watch anamorphic DVD movies. Since the television is the same shape as the movie picture, the picture fills the whole screen and is shown at maximum resolution. The problem now is that watching a standard television broadcast suffers from having blank areas on each side of the picture, since it was intended for a 4:3 television and is too narrow for the wide-screen set. Another solution is to buy a 4:3 television set that can squeeze the scan lines into the visible picture area when displaying 16:9 video. This feature is called *vertical compression* or *anamorphic squeeze,* and it is becoming a more common, though expensive, option on new 4:3 HDTV sets.

The HTPC can provide a solution for those with a 4:3 high-definition television. By up-converting DVD movies to 720p or 1080i, anamorphic video pictures will be displayed at maximum resolution. The black bars are still present at the top and bottom of the screen, but there is enough resolution left in the picture area to show the movie without distortion. No off-the-shelf consumer DVD player can do that!

NOTE *Some high-definition televisions, such as Sony's tube-based HDTVs, have a built-in feature that ensures that the black bars on the top and the bottom of the picture are not painted at all and that resolution is maximized. Unfortunately, televisions like this are few and far between, thus bringing the HTPC to the forefront to solve the problem.*

Improving Audio Quality

Traditionally, computer audio has been poor, more often the subject of ridicule and jokes than the standard benchmark of quality. Some bright spots in the history of computer audio exist, however, such as the sound capabilities of the Commodore Amiga or the futuristic tones of digital keyboard synthesizers, but in the past, most home computers had sound that was poor, bad, or nonexistent.

Digital Sound

In the later 1990s, computer processors became fast enough to handle digital sound (and indeed, even digital video). This led to a revolution in computer sound hardware. By the late 1990s, most avid computer users were disconnecting their PCs from the small, cheap speakers that came with the system and were instead connecting to high-quality sound systems and even their home stereo. Many people began to use the CD-ROM drive in their computer to play audio CDs, and then to decode and play back digitally compressed audio such as MP3 and WMA files. With the increase in hard disk capacity over the years, it is possible to store many hundreds of hours of compressed audio in a home computer.

When CD digital audio was introduced in the mid-1980s, it set a new standard of quality for sound and storage media. It was not until the early 1990s, when many new PCs were sold with CD-ROM drives, that computer buyers started to ask for sound capabilities in their new systems that could match the quality of sound stored on a CD.

Sound quality was important to computer game players, too. It is a little-acknowledged fact that the amazing innovation in computer games during the 1990s sold a lot of computer hardware and increased demand for graphics and sound capabilities. Each new generation of computer games needed faster computer processors, more memory, faster video hardware, and higher quality sound. These great advancements in video and audio capabilities pay off in a big way for home theater enthusiasts who want to build an HTPC because the home computer is now powerful enough to create a high-quality theater experience—and it can still play all those fantastic games!

CD Audio

The quality of CD audio has recently been surpassed. Chapter 3 explains how higher bit rates, increased sampling frequencies, and denser storage media have all led to new digital audio formats that store and re-create music at a higher quality than CDs. Newer sound hardware also supports digital inputs and outputs, so that recording and playing back high-quality soundtracks is possible. For the HTPC hobbyist, this means that upgrading to a new sound card capable of supporting 24-bit/96 KHz digital sound is more appealing, since it can now take advantage of more than just DVD movies.

A huge benefit that arises from using a PC to reproduce music is that when a new digital format is released, the computer can be upgraded or adapted to support it. With a large market of computer users who want premium-quality sound reproduction for computer games, home theater, presentations, and professional audio editing, it is a safe bet that the HTPC will remain at the leading edge of audio technology for years to come.

Networking the HTPC

Since the HTPC is still a PC at heart, it is perfectly suitable to networking with other computers. It is becoming common to find homes with more than one PC and to find high-speed Internet access available in many large cities. Adding computer networking capabilities to the HTPC (see Figure 2-2) is a great idea for many reasons.

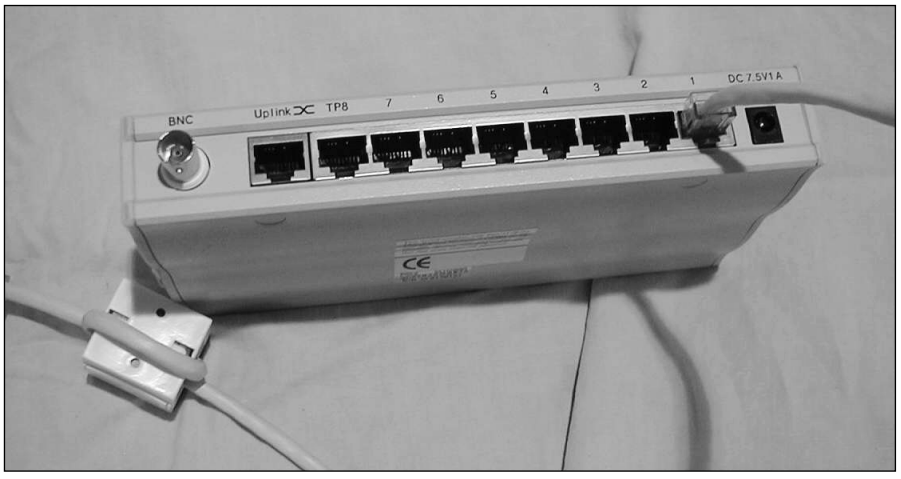

Figure 2-2. A network can add functionality to your HTPC, such as allowing it to bring audio files over from another PC.

A Media Player

First, the HTPC is essentially a media player, and it can benefit from the extra storage capacity that a computer network allows. In these days of digital convergence, when many media formats are digital, the computer can record, store, and play back these digital media. From CD audio music or digitized LP records to home movies or downloaded digital video clips, the media files use up a lot of space on a hard disk. The HTPC is a great machine to use as a media server in the home, where every computer connected to the same network can play the audio and video files stored on the HTPC.

The HTPC can also be used as just a player, with another computer on the network serving out files. By reducing the number of hard disk drives in the HTPC, the heat is reduced, and therefore the number and speed of fans needed to cool the system is reduced. This makes for a much quieter HTPC, which is a major consideration for most home theater rooms. It also allows for better performance for the HTPC, since it is dedicated to home theater tasks, instead of also serving files out to other computers on the network.

Internet Access

Second, the HTPC can benefit from networking where broadband access to the Internet is available. An HTPC with an Internet connection can be used for convenient access to e-mailing and Web browsing, and streaming media formats for Internet radio or video clips.

Even broadband Internet access cannot provide the minimum video quality that most people would find acceptable, though for some functions many are willing to make a sacrifice. The great thing about having the HTPC connected to the Internet is not to stream video, however, but to download it to the hard disk before playing it back. Many feature films and television shows provide preview video clips and movie trailers, which are of high enough quality to benefit from playback in the home theater. Watching a trailer on a conventional PC with a small screen and poor sound system is no match for the HTPC connected to a big television and digital home theater audio receiver.

Communication

The third major reason for networking an HTPC is for online chatting or videoconferencing. It is far more comfortable to gather people around the television in a home theater room for a videoconferencing session with distant relatives than to

crowd around a small PC monitor stuck in the corner of a spare bedroom or office. It is also more convenient to participate in Internet chats or instant messaging on a large display, where you can resize video from broadcast television to a smaller area of the screen while the chat takes place.

Gaming

The final reason for networking an HTPC may apply only to a portion of those who are interested in building and operating such a system. Computer games have become widely popular since the availability of multiplayer sessions on the Internet. Most games released these days allow a small number of players to connect to each other over the Internet and play a round or two. It is an experience unlike anything a player could find in a single-player game. Also, several massive multiplayer games are available on the Internet now. These games do not start and end when a few friends decide to have a session—they continue 24 hours a day as people come and go from the game server. The HTPC is quite capable of the performance needed to play most modern multiplayer computer games.

NOTE *The HTPC is a great system for game playing. Most gamers desire a video card that is optimized for speedy 3D graphics, and these features also give the card excellent MPEG-2 and DVD playback capabilities. No single video card is able to claim the best features and performance for games and video playback, so the HTPC must compromise on one or the other. However, the HTPC is still capable of playing modern computer games, and having the games presented on a big-screen display with ground-shaking audio can go a long way toward making up for the marginal loss of cutting-edge graphics performance.*

Using an HTPC

The HTPC is more than just a glorified DVD movie and CD audio player. It is a computer that specializes in high-quality audio and video, but it is also a computer that can perform all the functions of any other PC. Since this PC is located in the home theater, it often becomes the most convenient computer to use. In this section, we make some suggestions for uses of an HTPC and the hardware and software required for these functions. The functions intended for the HTPC will determine the size and shape of the system case, the location of the system, and the attachment of external peripherals. Intended functions will also affect the software that needs to be loaded and configured. The HTPC is very

adaptable, but as with all computer systems, planning ahead can save effort and frustration later on.

Putting the excellent audio and video capabilities of the system to good use requires some knowledge and time on the part of the HTPC hobbyist. Unlike off-the-shelf consumer equipment, an HTPC does not simply plug into the wall, connect to the television, and start playing movies. The system must be put together—sometimes right from scratch (this is the way most hardcore hobbyists prefer it!)—and then configured. Often this configuration needs several tweaks in order to find the optimal settings. An HTPC can be set up to behave like any other home theater component—point the remote and click a button—but achieving this level of simplicity takes a great understanding of the complexity inherent in the system.

TIP *Actually, the HTPC can be a "plug-and-play" device now. Several manufacturers have introduced HTPC products to the retail market. Though these machines never have the same balance of cost and performance that each individual prefers, they are just as configurable and upgradeable as custom-built systems. For those with limited technical skill, or little interest in assembling their own machine, the retail HTPC is a great solution.*

Each function of the HTPC requires hardware and software to support it. Many functions use the same hardware, such as the video card and sound card. Some functions require specialized hardware, such as a computer game that may require a joystick or game pad. Later chapters of this book explain precisely how to configure major components such as the video card and sound card. This section serves as an overview of what's available to you and what you should consider when planning an HTPC system.

Playing DVD Movies

This functionality is perhaps the most popular use for the HTPC. It is also a great measurement by which to assess the capability to perform other functions. A system that can play back DVD movies with optimal video and sound will also be able to perform most other home theater tasks with excellence.

We discussed the advantages of using an HTPC to play movies earlier in this chapter. With the low cost of DVD-ROM drives today, almost all PCs shipped to consumers include them. This does not guarantee that the system is suitable for

DVD movie playback in a home theater, however, and it may not mean that the system can play DVD movies at all.

Required Hardware

In addition to a DVD-ROM drive, the HTPC requires a sound card. Sound hardware is usually added to a computer system by including an add-in component called an *expansion card,* or more specifically, a *sound card.* Sometimes the sound hardware is added to the main system board, also called the *motherboard,* instead of adding it separately. This saves some cost and makes the system cheaper, but it is notoriously difficult to upgrade systems that have sound hardware on the motherboard. Instead of simply swapping one sound card for another, the system must be configured to switch off the built-in sound hardware before a new sound card is added. Switching off such built-in sound hardware may require a jumper to be moved or a system BIOS setting to be altered, and unfortunately there is no standard regarding this procedure. The good news is that some motherboards are available with very high-quality sound hardware built in, including digital audio output and surround-sound analog connections for full surround sound speaker sets.

Sound

The digital surround soundtrack from a DVD movie can be read by the DVD drive and sent to the sound card, and then sent directly to an external digital decoder such as a digital receiver that supports the Dolby Digital 5.1 and DTS 5.1 formats. This is usually the preferred way to configure the home theater, since the digital receiver/decoder has more power to drive the speakers than the PC. For such a setup, the sound card needs to have a digital output. This may be either a coaxial S/PDIF connector or an optical Toslink connector. Be aware that some sound cards with the S/PDIF connector use a nonstandard voltage to send digital information because they are meant to be used only with the manufacturer's external hardware. Some Creative Labs sound cards are like this. Also, most computer sound hardware with a digital audio output uses a mono DIN output connector, which requires a converter to connect a standard RCA-type digital audio cable.

Some sound cards do not preserve the quality of the digital audio from the DVD. They down-sample the 24-bit/96 KHz sound to a lower rate supported internally by the sound processor, and then up-convert it again when it is output through the digital output port. This causes some degradation in the final sound quality. A lot of cheaper sound cards, such as the low-cost cards from Creative Labs and C-Media, will do this.

Video Output

Most computers are not capable of sending video output to a television, since a standard television requires an analog video signal that is very different from the normal Video Graphics Array (VGA)–type signal that is sent to a computer monitor. For an HTPC that will be used to display on a standard NTSC television, a video card that has an NTSC output port is required. This is not an uncommon feature for computer video cards, and it adds only a small extra cost to the hardware, but many systems do not include such features.

For the serious home theater enthusiast, the HTPC must be able to output video compatible with the high-definition television standards that have recently been introduced. Computer users familiar with the display settings of their computer will notice that the PC has the capability to output a great variety of resolutions and refresh frequencies, many of which are even higher quality than the highest HDTV standard. For those HDTV sets with a VGA input, connecting the HTPC is only a matter of plugging in the video cable and setting a compatible display resolution and refresh rate. For the vast majority of HDTV sets without a VGA connector, another piece of hardware is required.

The device that converts the VGA output of a computer to the component inputs used by an HDTV set is called a *transcoder.* It is also known as a *converter,* a *component adapter,* or a *break-out box*. It is a little box with a VGA input and a component output, and inside it converts the VGA signal to the Y-Pb-Pr signal of the three-line component output. It is an external device that sits behind the HTPC. Transcoders are not widely available or easily found at local electronics retailers. The normal method for acquiring one is to order it from an Internet merchant. Though inconvenient to procure, the transcoder is one of the most critical components of the HTPC system.

ATI has recently begun to offer a special transcoder for their Radeon 8500 and 9700 series of video cards. This transcoder is much less expensive than other converters, though it only works with the ATI hardware and it has some output limitations. Overall, it seems to be well received and offers a very high-quality video picture.

Many front projection televisions and some rear projection televisions do not require a transcoder; they require an RGBHV cable connected directly from the HTPC to the projector or television. The RGBHV cable is a cable that converts the VGA-type connector on the back of the PC to the red-green-blue connectors on the display. This cable is also expensive and relatively difficult to find, but it is cheaper than a transcoder since it does nothing more than reroute the wires from the VGA connector to fit into the inputs on the television set.

Required Software

With all of the required hardware installed, the HTPC still cannot play DVD movies without software. The HTPC needs a DVD movie player application to read the movie information from the DVD player, decode it, and display it on the screen and output the sound to the sound card. Software players are not commonly included with computer operating systems, so you must purchase the application. Since not all software DVD players are created equally, it is helpful to know the features of the available applications and which ones are considered best. Chapter 9 of this book includes information about popular DVD movie players.

NOTE *The reason that DVD movie-playing software is only available for purchase is that DVD movies are encrypted on the disc, and only licensed manufacturers have the keys to decrypt the movies. Each brand of consumer DVD player has a unique key that can play an encrypted DVD movie, which the manufacturer has to pay licensing fees to use. Publishers of software DVD players must also pay to license a decryption key, so not many of them are keen to give their products away. Even video card manufacturers that provide DVD playing software for their hardware are careful to ensure that the player is either not easily accessible to noncustomers or does not work on other types of video hardware.*

You need to install and configure all of the hardware and software needed to play DVD movies. We provide complete details about installing hardware and the software drivers that support the hardware and installing software applications in later chapters in this book.

Using the HTPC As an Audio Jukebox

The convenience of converging audio formats into an HTPC is unmatched by any other device currently available. Even a massive 200- or 300-disc CD audio carousel cannot store as much music as the hard drive of an HTPC (see Figure 2-3). Plus, when it comes time to find a desired audio piece among such a massive collection, only the HTPC has the versatility of indexing and instant play that a computer can offer.

Figure 2-3. Portable MP3 jukeboxes, such as the Creative Labs Nomad Jukebox shown here, can't touch the functionality and storage space of an HTPC.

The key to storing large amounts of music and other audio in a computer is digital compression. The benefits and drawbacks of using psycho-acoustic sound compression, such as the MP3 or WMA format, are discussed in Chapter 3. Some audiophiles find the concept of digital compression unacceptable—for those not willing to digitally compress music, the storage capacity of the HTPC is markedly reduced. Whatever the format, however, the limits of storage are only set by the capacity of hard disk drives installed in the computer.

Required Hardware

The HTPC will have a sound card—without one it would be little more than a video player. This may suit some special purposes such as business presentations or slide shows, but the machine of interest to this book is for a home theater, and so the need for a sound card is unquestionable. However, the performance and specifications of the sound card may be questioned.

An HTPC that is meant primarily for playing music may not require anything more than an average sound card. Because CD audio quality is measured at 16-bit/44 KHz, and sound cards sold today (and indeed for many years now) are all compatible with this standard, most audio playback will not benefit from more expensive sound hardware. The only requirement is to select a good quality unit that is compatible with the operating system with which it is intended for use and that has the appropriate connectors to support the desired function of the sound system.

CAUTION *Some sound cards have compatibility problems when they are used with certain motherboards in combination with certain operating systems. See Chapter 5 for specific details about problems that we encountered when researching this book.*

Sound Card Connections

The connectors on the sound card will determine what uses the HTPC has for audio jukebox functions (see Figure 2-4). The sound card will have, at the least, a speaker output to connect the system to external speakers. This is not usually the desirable way to configure an HTPC in the home theater, however. The sound card should therefore have a *line-out* connector to send audio to an external receiver/amplifier, which has more power to drive larger speakers. This line-out connector is almost always a ministereo jack (1/8 inch), and it is easy to confuse the speaker jack with the line-out jack, so you should take care to note that the sound card includes a line-out connection. The line-out is an analog port that sends audio at an appropriate level for the external receiver/amplifier. Although you can use the speaker output if there is no line-out, a proper line-out connector is preferable.

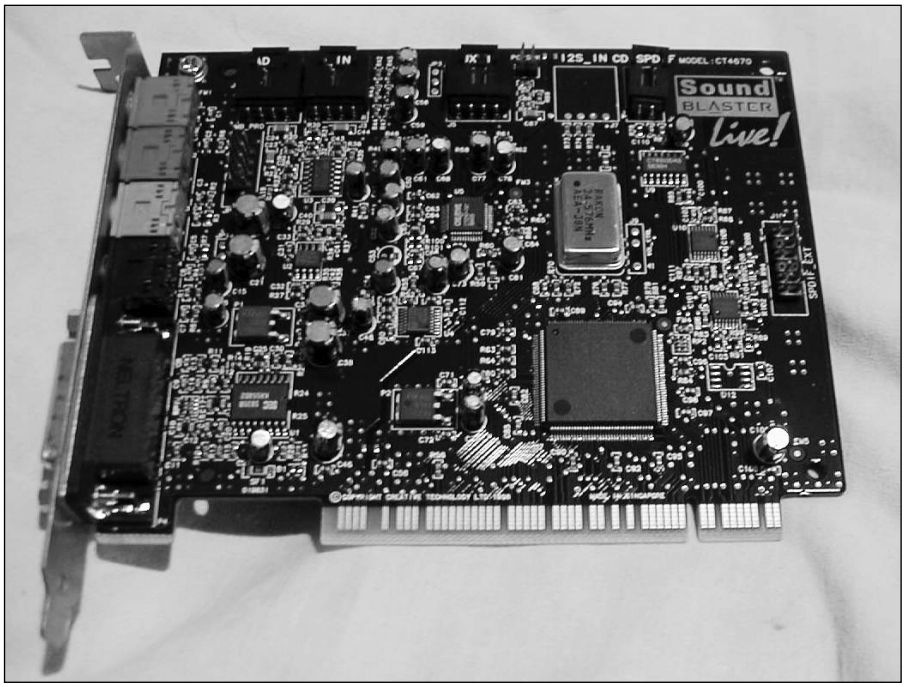

Figure 2-4. The sound card will determine how the HTPC performs with jukebox functions.

Digitizing Audio Sources

To use the HTPC to digitize other audio sources such as an LP record or an audiocassette, the sound card should have a *line-in* connection. This is similar to the line-out port in that they both handle analog audio at the same voltage level, but the line-in allows the sound hardware to receive sound connected from an external receiver/amplifier. Without a line-in connection, there will be no way to convert analog sound sources to digital format for playback on the HTPC.

Most sound cards include a microphone jack. Not all HTPC hobbyists will need one, but there are a few uses for the microphone jack that we discuss later in this chapter. An important point to remember is that the microphone jack is not the same thing as a line-in jack—they operate at different voltage levels, and confusing the two can cause damage to the sound hardware in a computer.

CAUTION *Never plug a line-level input meant for the line-in port into a microphone input connector. The microphone connector uses a very low voltage, and sending the higher line-level voltage into it can cause damage to the audio circuitry and will cause painfully loud distortion to be heard. The microphone jack and the line-in jack are the same size, and they are often not well labeled, so you must take special care when connecting line-level inputs.*

Connecting Speakers

Some sound cards feature an extra set of speaker outputs for use with extra speakers. The surround sound formats for computer games are not all compatible with home theater surround sound, and these extra speaker outputs are generally not useful for an HTPC. Some sound cards are capable of outputting standard 5.1 surround sound to speakers connected directly to the system, so in that case the extra speaker connectors may be desirable if the HTPC is not intended for use with an external digital audio receiver/amplifier.

More expensive sound cards also feature extra line-in connectors (see Figure 2-5). These allow the HTPC to be used to mix audio sources in real time, which is the common method of producing professional video and audio segments. These extra connectors are not necessary for the home user wishing to mix audio, since there are other methods of doing so, but for those hobbyists who need to combine audio from multiple sources simultaneously, a sound card that features multiple line-in connectors is worth the extra cost.

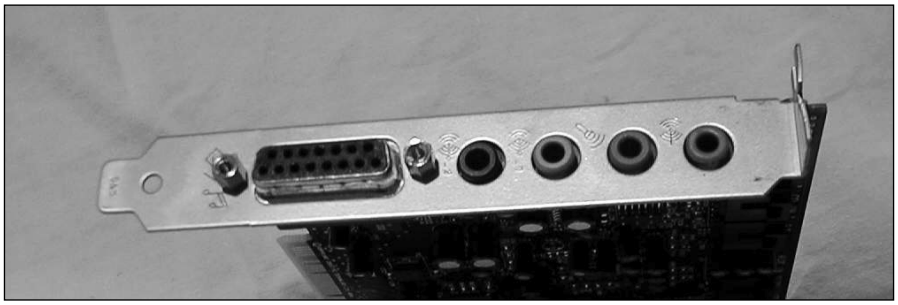

Figure 2-5. Modern sound cards have an entire row of connections.

The final type of connector to consider is the *digital input and output port.* Chapter 3 has more information about the development of the S/PDIF and Toslink digital connectors. These are becoming more common on sound cards, though digital input connectors are still quite rare. Even cheap sound hardware can be used to reproduce high-quality digital sound since the sound card does very little processing of the digital audio stream, except to pass it through the output port to the external receiver. A digital input port requires more processing to accept an audio stream from an external source, so this audio hardware remains relatively expensive.

For the Future

If you're going to use the HTPC for newer digital audio formats, such as DVD-Audio or Super Audio CD (SACD), it is worth investing in a higher-quality sound card. Where CD audio specifies a quality of 16-bit/44 KHz stereo, newer formats reach up to 24-bit/96 KHz with 5.1 channel sound, and beyond. Playing such formats through a standard 16-bit/44 KHz sound card will cause the high-quality digital sound to be down-sampled before it is output by the sound card, thus losing all the benefit of the higher-quality format. For such uses, you should use a 24-bit/96 KHz sound card. Since DVD movies feature audio that can reach up to the 24-bit/96 KHz measurement, the investment in such a sound card is not purely for audio formats, though such high-quality bit rates are extremely rare on DVD movies.

The high-quality 24-bit/96 KHz sound cards all feature digital output ports, which are the preferred way to send digital audio to an external digital receiver/amplifier. The line-out port on a sound card sends the analog sound that has already been decoded to the receiver. This analog sound is susceptible to interference and degradation as it travels through the cable between the HTPC and the receiver, and other electrical fields from other home theater components may affect what finally reaches the speakers. A digital signal is not affected as badly, since the bits are correctly decoded in the external receiver/amplifier as long as they arrive with enough coherence to be read as bits. Since the HTPC can output all audio through the digital connection, the best quality of sound is preserved for all formats.

Required Software

You have several choices of software applications that play various types of audio on the PC. Some of them can only play back one file and must be requeued for each successive piece, and some of them can play file after file, continuously, repeating a track or the entire program infinitely. Some audio players can only play CD audio, while some can play CD audio and compressed audio files, and yet others can play all those types plus video and streaming media from the Internet. An application that can play back various media types, file formats, and audio sources is called a *software jukebox*.

The jukebox you choose to play back audio files depends on what features you prefer and what cost is acceptable to you. Several of the jukeboxes are free but require registration and potentially undermine privacy. Some of them can automatically convert a CD audio disc to a digitally compressed audio file, and some require extra steps to do so. To see some example jukebox applications and get more details about them, see Chapter 9. Whatever your preference, the HTPC will need some kind of software jukebox to organize, record, store, and play back audio files.

A growing trend for digital audio enthusiasts is to convert all media formats to compressed audio files on the PC. To compress a digital audio file recorded from an analog source or CD audio disc, the jukebox application requires special software called a codec. Some codecs are included with jukebox applications, and some can be added separately from the Internet or from other applications. The HTPC will likely acquire a long list of them through its lifetime.

There are various digital compression methods available to the HTPC, each one with its own codec. Some of the more common ones are MPEG-1 layer 3 (MP3), Windows Media Audio (WMA), and RealAudio (RA). With good jukebox software, the HTPC can record and play each format easily. With an Internet connection, the jukebox application can even look up the album title and song names of CDs that are being converted to compressed audio files, saving you the time and effort of typing the information into the HTPC manually.

The greatest advantage of using the HTPC to play audio is its capability to store, organize, and access a massive collection of music. It does not require a specialized, expensive sound card to start a system capable of CD audio quality playback. Yet you can configure the HTPC with the highest quality audio hardware available to reproduce new digital audio formats without losing a single nuance. Though the HTPC may be considered primarily a DVD movie player, it is also an unmatched audio player.

Using the HTPC As a Television Tuner and HDTV Tuner

As mentioned earlier in this chapter, the HTPC can scale up any video source to match the highest quality available from the display device. This makes the HTPC a good way to receive standard television broadcasts and scale them up to a high-quality television or projector. If the display device is a standard NTSC-compatible television, then the HTPC is still a convenient device to use as a television tuner, if only to avoid switching between different input settings on the television.

Most HDTV sets sold do not have an HDTV tuner built in. This is partly because of the extra cost (HDTV sets are already much more expensive than standard televisions) and partly because the broadcast standards were not agreed upon until quite recently, as we noted in Chapter 1. Instead of purchasing an external HDTV tuner for high-definition-capable sets, you can add this functionality to an HTPC for a lower cost and with more configuration options.

Required Hardware

Television tuner cards for PCs are becoming quite inexpensive. Most of them not only provide a tuner for cable or over-the-air broadcasts, but they also have video inputs to accept video from VCRs or camcorders. The quality of a computer television tuner card is usually quite good (easily comparable to a good television set or VCR), and they are capable of tuning the more than 100 channels used in some markets today.

Television tuners for computers are available in two physical varieties: internal expansion cards and external devices. The external television tuner usually plugs into the computer via the USB bus, which causes some problems. The USB 1.0 bus specification allows for a maximum data transfer rate of 12 megabits per second, which is not enough to send the full 525 lines of NTSC television to the computer, so the video is scaled down to reduce the amount of digital data that needs to move across the bus. The newer USB 2.0 specification allows for a much higher data rate (480 megabits per second), which will make newer USB television tuners better.

Internal Tuners

Internal television tuners look like other computer adapter cards, and they usually use the faster PCI bus inside the system. These tuner cards are able to send the full 525 lines of resolution to the PC, so they provide better picture quality. It is preferable to use an internal television tuner card for HTPC purposes, since the quality of video is a prime concern for the HTPC hobbyist. Some video cards have television tuners built in, which also provides optimum television quality.

HDTV Tuners

Tuning HDTV is a more complicated subject. Tuner cards for HDTV are just like internal television tuner cards for standard NTSC broadcasts, but the HDTV signal reaches the home in only a few restricted ways. Over-the-air broadcasts of HDTV are available in a few markets, and only a few channels are currently being broadcast even in the largest markets. The HDTV tuner card can only tune these over-the-air broadcasts. The HDTV channels on digital cable boxes and digital satellite services are not accessible to the HDTV tuner card. Though this may seem to make an HDTV tuner card a rather useless accessory, it is for this very reason that the HTPC is a good place for receiver HDTV: Why pay a lot of money for an external HDTV receiver of limited use, when HDTV tuner cards for the PC are much less expensive?

NOTE *It is hardly worth putting an HDTV tuner card into an HTPC that is not connected to a high-definition television: The high-resolution video will be down-converted to standard NTSC-quality video, which is available from a cheaper NTSC television tuner card.*

It seems that all HDTV tuner cards also tune standard NTSC broadcasts, not only from over-the-air antennas, but also from the coaxial cable television service in most homes. For those interested in experiencing HDTV in the home theater, an HDTV tuner card for the HTPC is a great way to do so economically.

NOTE *Television tuner cards cannot replace digital cable boxes or digital satellite receivers. The security features of these components do not allow PC component manufacturers to make adapter cards for them. Though some are available from foreign distributors, they cannot be legitimately activated for domestic systems. The best solution is to get a television tuner card with a video input so that the output from these external decoders can be routed through the HTPC.*

Required Software

All television tuner hardware comes with the software necessary to watch television on the computer. Also, there are some third-party software applications available that you can use with many different brands and models of television tuner cards. This third-party software is usually pretty good because it includes extra features and configurations that give you more control over picture quality or other card features. For this reason, when you select a television tuner card, you should evaluate the software that works with the card.

Using the HTPC As a Digital Video Recorder

In the late 1990s an alternative to the VCR was introduced to the consumer market. The *digital video recorder* (DVR) is also known as a *personal video recorder* and by the brand names TiVo, ReplayTV, and UltimateTV. The DVR is a video recorder that digitizes the audio and video signal from a television and stores it on hard disk drives inside the unit.

The DVR is much more versatile than the VCR. Not only can the DVR play back the video that it has recorded, but it can also play it back *while* it is recording. This means that the viewer can pause the playback while the DVR continues recording the live broadcast, and then continue the playback while the unit is recording. This allows for some other neat functions, such as the ability to skip commercials by tuning into a show 10 minutes after it starts and the ability to jump ahead when the commercials are played, eventually catching up to the live broadcast just as it ends.

The DVR is finally becoming very popular, and adding this capability to an HTPC is an attractive option because the system already has most of the hardware necessary. It is largely a matter of selecting the best software to use for personal video recording.

Required Hardware

There are a few points to note about hardware that an HTPC should have to function as a DVR. The capability to output video to a television or high-definition television has already been discussed, and as a core component of the HTPC it is necessarily included so that the DVR has a way to output video to the home theater.

To get video into the DVR the HTPC may include either a television tuner card (or HDTV tuner card) or simply a video input. This choice affects the way the HTPC can be used as a DVR to record television or other video programs. With a television tuner card, the HTPC can be used to tune channels for recording, allowing for convenience when setting up a recording schedule or when channel surfing. In contrast, a simple video input also allows the DVR to record video, but it cannot select what channel is being recorded; it can only record what is being fed into it. The external video source may be configured to switch channels and programs automatically, but the DVR can only be set to record at scheduled times.

For those interested in using the DVR like a conventional VCR (i.e., setting a recording schedule for later viewing), a television tuner card is more appropriate. If the primary purpose of the DVR is to pause live programs or replay segments of a live program, then a television tuner card is not necessary, since the HTPC can be connected to whatever video source is being watched.

Hard Drive Requirements for the DVR

Hard disk drive performance has a large bearing on the quality and performance of the DVR. A standard NTSC video is usually rendered on the computer at a resolution of 640×480 pixels (remember that the 525 lines specified by the NTSC standard are not all visible—only about 480 horizontal lines are actually used for the image) and at a color depth of 24 bits, which is required for true color representation. This means that the video stream will be digitized to 27,648,000 bytes per second! Most hard disks will have trouble keeping up with this data rate.

There are some ways to improve the hard disk performance. One way is to digitally compress the video before it is written to the hard disk. This helps because less information is written, so the disk performance is not as taxed. Compressing video takes a very fast PC, though, so unless the HTPC features a top-of-the-line CPU, it will not be able to compress the data fast enough to capture it at good quality.

TIP *Since HDTV has a much higher resolution than NTSC television, recording it to a hard disk must be almost impossible, right? Actually, recording HDTV data to a hard disk is easier than recording standard NTSC video. The HDTV broadcast is already compressed to MPEG-2, and the compressed data stream can be recorded before it is decompressed for display. An HDTV broadcast at 1080i quality actually uses less bandwidth than a standard television channel.*

Another way to improve performance is to scale down the picture size. Instead of capturing 640×480 video, the DVR can reduce each dimension by half and capture 320×240 video. This has the effect of reducing the data rate to one quarter of the full size rate. Unfortunately, this affects the quality of the video being captured. For some purposes it may not matter, but there may be some programs for which preserving maximum quality is essential.

The most effective way to improve disk performance is to build a disk array called a *striped volume* or *RAID 0*. A RAID is a *redundant array of inexpensive disks,* and RAID 0 is the technical term for using two or more disk drives as one logical drive. The computer data is striped evenly between the disks, and since the computer can read and write to each drive at nearly its full performance, the performance of the logical volume is essentially doubled compared to using one hard disk drive.

To build an HTPC with the ultimate performance, you should consider a disk array. Even a two-disk striped volume is fast enough to capture full-quality NTSC video without losing any data. Adding another disk drive to the HTPC does have some consequences, including higher costs and a louder system, but it cannot be matched for disk performance. Chapter 8 provides more details about this method of improving disk performance.

Required Software

The field of DVR software is a very new topic, but there are already some great choices available. Some DVR applications even allow you to record HDTV broadcasts, which is otherwise impossible—there are no consumer devices available on the market to record HDTV. For more information about DVR applications, see Chapter 9 of this book.

NOTE *The consumer electronics industry is struggling with HDTV recording. It is a difficult issue because it would allow consumers to make perfect digital copies of high-quality television shows and movies in their home. Broadcasters are reluctant to allow this, and they are putting pressure on manufacturers to find ways to protect digital content from unauthorized recording and distribution, which is causing the release of recording products to the marketplace to be delayed.*

Editing Video

As we mentioned in Chapter 1, the HTPC is an excellent tool for importing analog (and thereby converting it to digital) and digital video. Once in the HTPC, you can edit the video using a number of software packages. The resulting edited video can look remarkably professional and you can even burn it onto DVD or Video CD to keep it forever. Several devices on the market allow you to import analog video at a low cost, and of course digital video cameras come complete with an IEEE 1394 port (a FireWire port) that allows the camcorder to be connected directly to the PC (see Figure 2-6). FireWire is an extremely efficient communication channel, and it can handle the huge amount of information that must flow between the camcorder and the HTPC.

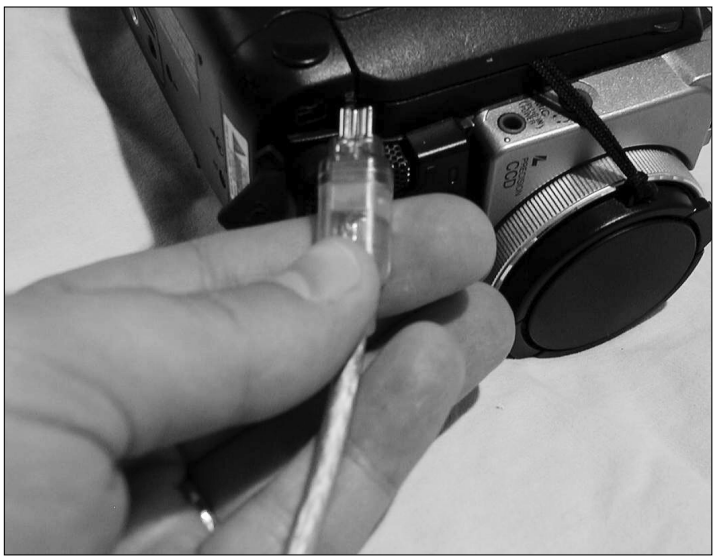

Figure 2-6. Digital camcorders are a breeze to connect to a properly configured HTPC.

After you've placed the video on the hard drive of your HTPC, you can edit the resulting files into large or small clips and put them in any order you desire. You can add in multiple audio tracks, music, and even special digital effects such as ghosting and sepia tone. If you have a large enough hard drive on the HTPC, you can have these movies sit there and play them right off of the HTPC onto your home theater screen (whatever it may be) whenever you need a little nostalgia. See Chapter 11 for details on how to use your HTPC as a home movie (or business presentation) workshop.

Viewing Slide Shows

Storing a huge collection of images digitally on an HTPC makes a lot of sense. Digital images do not fade or lose color over the years, and gathering friends and family in the home theater room to view images on a large screen television can be more fun and intimate than passing around a photo album or a stack of prints. Just like with a music collection, digital pictures can be indexed and accessed very quickly on the HTPC, and the whole picture experience can be enhanced with background music. It is also easy to switch from home movies to pictures and back again, providing a rich multimedia display to document camping trips, graduations, and other life events—even just really good parties!

Required Hardware

Using an HTPC to show digital pictures on a television is pretty trivial if the HTPC is already connected to a display device. It is important to realize that still pictures, more than video, benefit from higher resolution displays. Connecting the HTPC to a high-definition television makes quite a difference in quality compared to a standard television.

There are two main ways to get pictures into the HTPC: you can scan them from film prints by a picture scanner or you can take them with a digital camera and download them into the PC. A scanner is often the least expensive way to digitize an existing collection of prints. Many people have photo albums and family pictures that go back for generations. Even low-cost flatbed color scanners are capable of digitizing pictures at a very high resolution and color quality. In fact, most consumer scanners can scan a picture at many times the resolution that can be reproduced even on a high-definition television.

Digital Cameras

Digital cameras (see Figure 2-7) are more expensive than scanners, but they are becoming comparable in price to film cameras. Shooting pictures with a digital camera is very convenient and cheap—you don't have to wait until the pictures are developed to see how they turned out, and you don't have to pay for developing the pictures, either. Most people find that shooting with a digital camera motivates them to take many more pictures than they would with film, where each picture costs a little bit to develop. However, unless digital pictures are taken with a fairly high-resolution camera (which means a fairy expensive camera), they won't have as high a resolution as scanned film prints. This may not be a problem if you plan to only show the images in the home theater, but it is a problem if you want to make prints from the digital images.

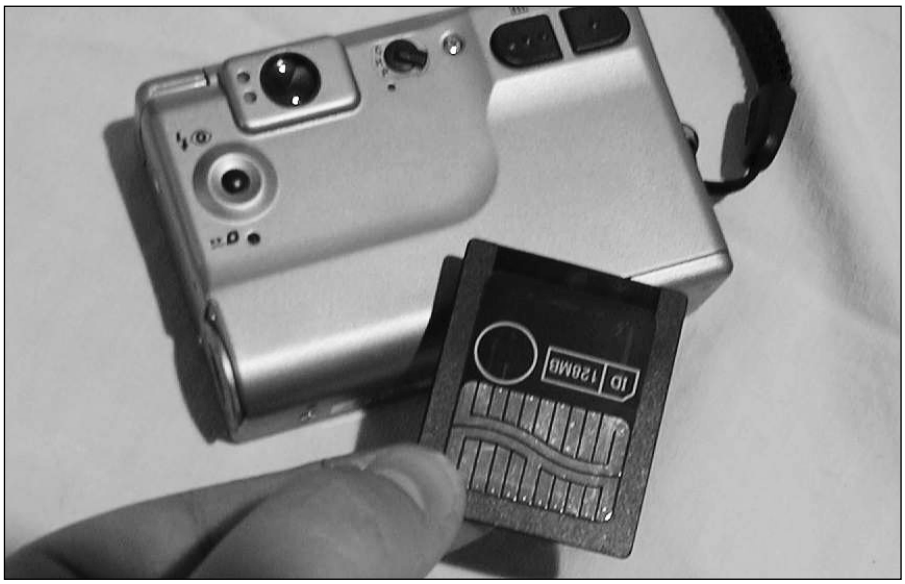

Figure 2-7. Digital cameras are fast becoming the default method to get pictures into digital format.

Required Software

Several image viewing applications are available that can display digital images at full screen size, scaling small images up and large images down to fit the display. Good viewing software also allows you to jump from one picture to the next easily and without distraction. In this manner, you can show all the images in a collection in sequence without having to find each file in turn. You can configure automated slide shows to flip to the next picture at a specified interval, which makes a nice display while listening to music on the HTPC.

For capturing and processing images, an image tool that allows rotation is essential. Images from a digital camera that are shot in *portrait orientation*—that is, the camera is rotated 90 degrees to make the image taller than it is wide—must be rotated after they are captured in the computer so that they display the right way up. Some image editing tools also provide neat picture filters that make the image look black-and-white, drawn with crayon, etched in metal, or painted with watercolor paint. With digital images, you can also add captions and speech bubbles to snapshots of friends and family.

Videoconferencing

The average quality of video streamed over the Internet is relatively poor when compared to the quality of standard television, but the entertainment value is arguably much higher. Even those fortunate enough to have access to broadband Internet connections still suffer low video resolutions, poor sound quality, and annoying glitches and delays. Putting this experience into a home theater seems pointless, but you must not underestimate the fun to be had with friends, kids, grandparents, and pets all trying to see each other in the home theater room!

The home theater really is a great environment for videoconferencing with groups of people, since there is generally more room to sit and be comfortable than when the videoconference is done in a spare room, office, or basement with everyone crowded around the computer monitor. And if broadband Internet access is not available in your area, you can still use the equipment to record messages and short videos to e-mail to your friends and family.

Required Hardware

In addition to the usual HTPC requirements of displaying on a television or large display device, videoconferencing requires a video camera of some sort. Generally, when people think of videoconferencing, they think of *Webcams,* small cameras that connect directly to a computer. These are suitable for videoconferencing on the Internet, since they usually support only the low resolutions that can be streamed back and forth. They are also small enough to be placed on top of the television, which is the ideal place from which to capture video, since everyone will be looking at the television.

Camcorders and other analog consumer video cameras are also suitable for videoconferencing, but because they cannot connect directly to the HTPC, they must be connected to a video input port or video capture device attached to the system. Though the video quality may be too high to stream efficiently across the Internet, the HTPC can down-sample it to a more suitable data rate. The nice thing about using a camcorder is that you can use it for more than just videoconferencing.

TIP *Using a camcorder as a video camera for videoconferencing may be inconvenient if the camera has a default time-out to shut itself off. Unless it is recording, a video camera may stop capturing video after a few minutes to save battery power. In this case, you may have to keep a "scratch" tape handy to record your sessions to keep the camera turned on.*

Unless the camera has a microphone built in, you will need to provide audio for the videoconference. This microphone may be connected to the microphone jack on the sound card. You should place the microphone away from speakers in the home theater room to prevent audio feedback. Also, many cheap microphones are only meant to be used at a close range—within a few feet—and are too weak to pick up sound from across a room. The specifications on the microphone's packaging should indicate its effective range.

Required Software

Videoconferencing software is not difficult to find or expensive to acquire; it is mostly free, in fact. Don't expect to get high-quality video streaming across the Internet, though, no matter what the cost. The limiting factor is the speed at which the HTPC can send and receive information on the Internet. A video image at 320×240 pixels is quite good, even for broadband Internet subscribers. The videoconferencing software should optionally scale the video up to the size of the screen, though the result may be very blocky or blurry. A better suggestion is to use one half of the screen for the received video and the other half to watch the video that is being sent.

Instead of sending video and audio, some software allows people to connect with each other with only audio. Using the Internet to make phone calls, and especially to make long-distance phone calls, has become popular as Internet connection charges have dropped. It is cheaper to talk for hours on the Internet with someone in a different city than to make a long-distance phone call, and a broadband Internet connection is not even necessary.

E-mailing and Web Browsing

Using the HTPC for e-mail is very simple. It requires no special hardware or software that would not normally be found on a conventional PC. The only advantage to using the HTPC for checking e-mail is the convenience of having it on a PC that is always nearby and usually turned on. Since there is not likely to be much privacy for reading or composing messages, it is a good idea to use the HTPC for a general e-mail account shared by members of the household. It is also a good idea to turn off any audible message warnings so that new e-mail doesn't play a loud ping or a "You have new mail!" greeting during a movie or television show.

E-mail

Many e-mail programs are integrated with scheduling and calendar software, which is another convenience that the HTPC can bring to the home theater. Having a daily schedule in the home theater room where it is conveniently accessible is a great help, and having critical reminders and notes pop up on the screen can save embarrassment and problems for even the most absentminded.

Web Browsers

Web browsing on the HTPC is a great function for sharing Web site information with others in the room. The display is usually conveniently visible to other people in the home theater, and those people do not have to look over someone else's shoulder to see what it is that the person is trying to show them. Many Web sites feature entertaining animations and movies, which are also conveniently displayed with the HTPC.

Using the HTPC for e-mail and Web browsing makes having a high-definition display very appealing. Standard televisions do not have enough resolution and cannot show enough detail to make reading text on the screen comfortable or easy. While image detail may be blurred without much notice, the display of large amounts of text demands a high-resolution television.

Remote Controls

In Chapter 7 of this book we discuss various remote controls for the HTPC and wireless keyboard and mouse features (see Figure 2-8). Generally, most features of the HTPC only require simple commands, such as play, stop, change volume, next picture, previous picture, next audio track, and so forth, which can be mapped to a button on a remote control unit. If the HTPC is to be used for e-mail and Web browsing, a wireless keyboard and mouse are essential for comfortable use of the system. It would be time-consuming and tedious to try to write an e-mail message with a simple remote control. Being constrained by a keyboard and mouse cord to within a few feet of the HTPC may not be convenient, either, if the HTPC is located right beside the large screen display.

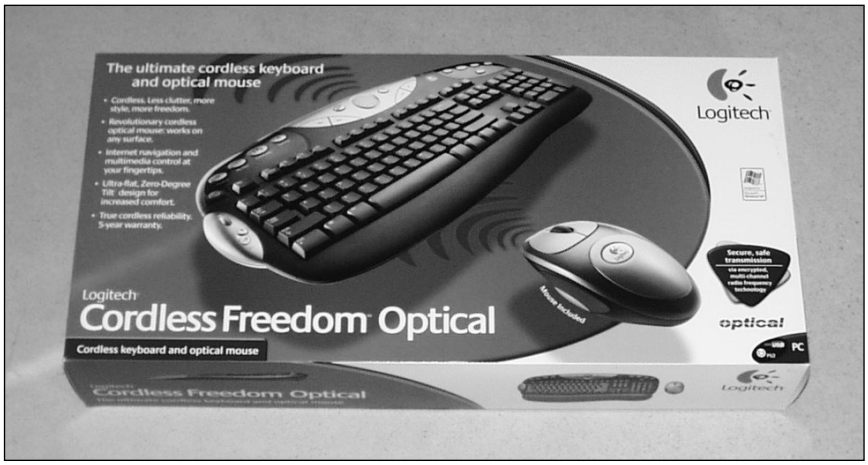

Figure 2-8. A wireless keyboard can make for the ultimate remote control.

Playing Computer Games

Most computer game enthusiasts are excited by the idea of playing their favorite titles on a big-screen HDTV, and the HTPC can make that idea a reality. Any genre of computer game can be played on a high-definition television via the HTPC, but the most visually impressive games are the ones that use 3D graphics to create rich virtual environments. These can include sports games, first-person shooters, auto-racing games, and even 3D adventure games. All these types of games benefit from the larger display and more powerful sound available in the home theater.

Required Hardware

Computer games that use 3D graphics depend largely on video cards that enhance and accelerate such graphics. The development of 3D computer games has driven the graphics card industry forward relentlessly, and indeed many gamers are serious enough about it to pay $500.00 or more for a top-performing video card.

As we discuss in Chapter 4, not all video cards are equally suitable for use in an HTPC. A PC that will be outputting video to a high-definition television must have a video card that can be set to custom resolutions and refresh rates, and most 3D video cards that are optimized for games concentrate on the standard PC display sizes. They also tend to favor high refresh rates, as this is desirable for computer monitors, but not for a high-definition television. The HTPC must sacrifice either game performance or video output performance, and most hobbyists prefer to sacrifice games in favor of DVD movies.

High-performance 3D graphics cards also generate a lot of heat, which must be dissipated with fans inside the computer case. Fans make noise, and noise is undesirable for an HTPC, especially one that sits in a quiet home theater room.

That is not to say that the HTPC is unusable for 3D video games, however. There are several good HTPC video cards that have acceptable 3D performance. Many computer game players will find the HTPC to be a great machine for computer games. Only the most hardcore 3D graphics fanatics will be unhappy with the trade-off of graphics quality for screen size.

For the past few years, computer games have featured 3D sound to go along with the 3D graphics, but the sound standards are not all compatible with home theater 5.1 surround sound. To hear the surround sound effects from a computer game that uses a noncompatible 3D sound process, the computer must have a sound card that supports the game's sound and speakers connected to the sound card. Unless such a sound card also supports the Dolby Digital 5.1 or DTS 5.1 surround sound audio from a DVD movie, it is unsuitable for use in an HTPC. Thus, some players may lose some of the gaming experience when playing on an HTPC.

As with e-mailing and Web browsing, a wireless keyboard and mouse are a great convenience when playing computer games on the HTPC. A wireless joystick is a nice game controller to have for flying games and flight simulators in the home theater. If a wireless keyboard and mouse are not available, the HTPC could be located closer to the seating positions in the room, or extensions for the connecting cables could be used.

Required Software

Playing computer games on an HTPC requires little extra software. Many computer games are published for the Windows family of operating systems. Such games generally require the DirectX software included with the operating system or available as a free upgrade for Windows. Games that use surround sound formats also need the software for the sound card installed to activate this feature. Instead of trying to accommodate a noncompatible surround sound format in a home theater, a game can be played in stereo sound, which diminishes the game's realism but accommodates its use with the existing sound system.

Summary

This chapter outlined several uses for an HTPC in a home theater. Its capability to play DVD movies at a quality matching the best high-definition television makes the HTPC a great investment. Even when it's connected to a standard television, the HTPC can provide advantages that surpass the capabilities of a conventional DVD player. Personal video recording and audio jukebox functions are a wonderful convenience of the modern home theater, and combining them into one versatile unit makes sense. This is especially true when the ability to upgrade hardware and software is considered. The HTPC need never become antiquated or obsolete; as consumer electronics makers innovate new "must-have" digital technologies, you can integrate them into the HTPC with relative ease. Because the HTPC is a fully functional computer, you can also use it for any task a computer is capable of, including word processing, video editing, and even chatting online. It is, in effect, the ideal home theater device.

The next chapter covers audio specifications in the HTPC.