Part 1

Core Components

Chapter 1

Five Easy Pieces: PC Hardware in a Nutshell

- CPUs, Peripherals, and Controllers
- Buses and Interfaces
- The Sixth Piece: Drivers
- Other PC Components and Issues

Introduction

If you have any experience buying, using, or fixing PCs, you've no doubt heard a bushel of strange terms—RAM, CPU, USB, PCI, FireWire, Athlon, Duron, Pentium, Celeron, Itanium, Centrino, you name it. Even more daunting is figuring out which acronyms—and again, there are a ton—to pronounce and which ones you simply spell out. For example, USB and CPU aren't words (you just spell out the letters), but RAM is "ram" and SCSI is "skuzzy." Don't expect the slang to get better any time soon, because this business *loves* jargon.

Since their introduction in the '80s, PCs have evolved nonstop. The most recent changes are bringing them more closely in line with consumer electronics such as video cameras, DVD players, mobile communications devices, and televisions. Standards seem less chiseled in stone and more written in shifting sand. Consumer electronics and PCs haven't really been able to talk to one another for very long.

But technology is rapidly moving toward a digital, wired (or wireless, if you prefer) world. With the advent of wireless technology, your notebook computer will automatically link up to your desktop computer, and while you're trying to figure out what's for dinner, your laptop will update the files on your desktop. You'll also be able to turn on the television with a single keystroke on the PC keyboard, and your PC's hard drive or recordable DVD drive will automatically record a television show while you work on a Microsoft Excel worksheet. Different companies are coming up with different ways to implement this type of technology, fueling a rapid-pace change in hardware and increasing the number of "standards."

Another common trend in recent years has been to put add-on hardware boards, such as video and sound cards and even modems, right on the motherboard to save a little extra money in production. Consolidation is a major theme; some major computer manufacturers sell computers with no expansion slots. Their reasoning is that any add-on hardware that's required can be attached via the Universal Serial Bus (USB) port.

If you don't know already, the motherboard is the central board in a PC to which everything else ultimately connects. The motherboard has a socket or slot for the Central Processing Unit (CPU), expansion slots to add other hardware boards that control features such as video and audio, ports to which devices such as your mouse connect, sockets for adding extra random access memory (RAM), USB and FireWire ports for attaching a multitude of peripherals, and connectors called Integrated Drive Electronics (IDE) channels for plugging in hard drives, CD-ROM drives, and DVD drives. You'll learn a lot more about them in Chapter 2, "Inside the PC: Core Components."

PC hardware *can* be confusing because there are so many parts to a PC—and some of these parts change pretty quickly. I wish I could write this book so that it completely avoids the geeky details such as, "USB version 1.1 supported speeds of 12 Mbps, whereas USB 2.0 supports 480 Mbps per second in order to compete better with FireWire," but ultimately you'll *have* to know some of that stuff or you won't really be effective as a buyer, upgrader, or fixer. Jumping in at that level right now, however, would probably convince the average reader that quantum physics would be a simpler course of study.

Knowledge really *is* power where computers are concerned. What you need, then, is some structure, along with a bird's-eye view of PC hardware. It's a lot easier to understand some new term if you have a classification system. What I'm going to explain in this chapter is the mental model that I use to understand PC hardware. It's not perfect—not *everything* will fit into this model—but I think you'll find it useful in your hardware education.

CPUs, Peripherals, and Controllers

Basically, PC hardware boils down to three kinds of devices: the CPU (or, as more and more machines offer multiprocessor capabilities, the CPU*s*), *peripherals* (the input, output, and storage devices that make a computer functional and user-friendly), and in-between devices that I'll generically call *controllers* or *adapters.*

For example, consider what makes it possible for the PC to put images on your video monitor. Every PC has a video monitor, and every PC also has a chip inside it called the CPU, often called the *processor,* which is essentially the "engine" of the PC. When you hear people say they have a "Pentium 4 computer," they're describing the particular model name of the CPU around which their computer is built. Common CPU names you might hear are Pentium (in various flavors, such as II, III, or the non-Roman numeric 4), Celeron, or Pentium M (which is the CPU brain of the popular mobile Centrino chipset); all of these are CPUs made by Intel. At one time, Intel had a monopoly on this market until other companies decided they could make CPUs faster and cheaper. These competitors include Advanced Micro Devices (AMD) with its Athlon, Duron, Sempron, and Opteron processors, and VIA Technologies, which markets the Cyrix MII, C3, and Eden chips.

In between the CPU and the monitor is a kind of diplomatic device—a circuit that knows how to talk to both the CPU and the video monitor—called the *video adapter* or *video controller*. If you ever see a reference to an S3 graphics adapter, a Super VGA (SVGA) adapter, or a 3D adapter, it's a reference to a video adapter. Video adapters contain memory that they use to retain the current video image, as well as onboard electronics that know how to do many useful graphical tasks such as drawing lines, circles, and polygons. Why is this important? Well, if you're ever in the middle of a World War II dogfight fighting for your life (in a PC game, of course), you really want your graphics to be smooth. One of the most important specifications today for 3D video cards is how fast they can draw a simple geometric shape called a *polygon*—measured in millions of polygons per second.

Interestingly, a large number of companies used to build video controllers, as well as components for other manufacturers' video controllers. However, with the price erosion of high-performance graphics controllers in the latter part of the '90s, many of these companies either quit making graphics controllers or made them only to sell to computer manufacturers for integration into motherboards. The result: fewer third-party video adapter boards for sale at the consumer level.

You'll see this CPU-adapter or controller-peripheral connection throughout all PC hardware; for example:

- Figure 1.1 shows speaker connections on a motherboard, and Figure 1.2 shows a Creative Labs Sound Blaster Audigy sound card. These illustrate the two kinds of sound systems used on computers since the early '90s. The first one is the small PC speaker that's attached directly to your motherboard. It doesn't make any cool noises, just simple beeps. The other is attached to special stereo sound circuitry that might also be built on the motherboard or on a separate circuit board that you plug into your motherboard. Once just cheap multimedia components, PC sound systems have risen in technology and performance, rivaling consumer audio.
- Most motherboards today have built-in circuitry to control Enhanced Integrated Drive Electronics (EIDE) hard drives, CD-ROM drives, and DVD drives. In fact, over 85 percent of all drives being used in PCs today use the EIDE interface. Because of the prominence of the EIDE interface (which is discussed in more detail later in this chapter), you might have to install a special adapter if you want to connect another kind of drive to your system. For example, if you want to install a Small Computer System Interface (SCSI) hard drive, you'll need to install a special SCSI adapter (also called a host adapter) in one of the expansion slots on your motherboard.

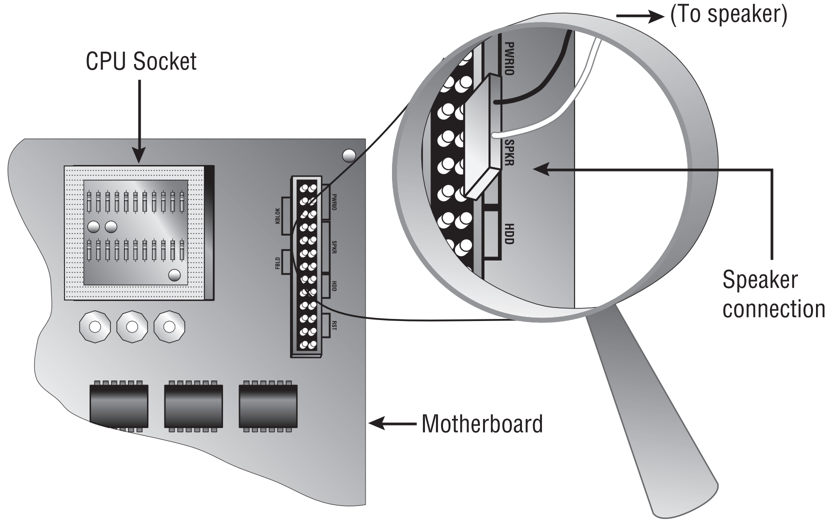


FIGURE 1.1
The PC speaker and its connection on the motherboard

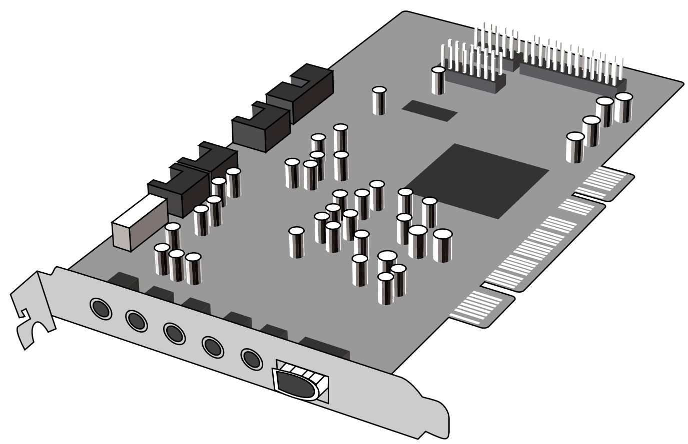


FIGURE 1.2
A Creative Labs Sound Blaster Audigy sound card

- To connect a printer to the PC, you'll need a parallel port or USB port.
- If you're connecting a scanner or a digital camera to your computer, you'll probably use one of your PC's USB ports.
- To use your computer as a video-editing bay, you connect your digital video camera to your PC's FireWire port—which is an ultra-fast way to transmit digital data from one device to another.

These are just a few examples of the different types of electronic components; you'll see tons more in this book.

Buses and Interfaces

But wait, you're not done yet. You have three parts of my PC model down—CPUs, peripherals, and controllers/adapters. I'd better explain two more pieces that I've already mentioned: *buses* and *interfaces.*

Let's say you're talking to a friend who just bought a new computer. Lapsing into fluent computerese, your friend says, "Hey, I just got this 3.2-gigahertz Pentium 4 with a gig of RAM, a 300-gig serial ATA hard disk, and an AGP 8X video card with 512 megs of RAM with DVI." Notice how your friend describes the computer—the first thing mentioned was a "3.2-gigahertz Pentium 4." As you've already read, "Pentium 4" describes the CPU, the chip around which the entire computer is built. Some people compare it to a car's engine—not a terrible analogy, with gigahertz being vaguely analogous to horsepower—but I'll take up CPUs in greater detail in Chapter 2.

The next part of the statement, "a gig of RAM, 300-gig hard disk, and AGP 8X video," refers to hardware *other than* the CPU—hardware that helps to make the computer useful. RAM is the computer's memory, a bunch of electronic chips that the CPU uses to store the program and data on which it's currently working. (RAM isn't a very useful acronym. What we ought to call it is "chips that the CPU can both store data to and read data from," but I suppose that would make for far too long an acronym.) I'll introduce RAM in Chapter 2 and discuss it in some detail in Chapter 6, "System Memory." What about "300-gig hard disk"? Well, "300 gigs" (gigabytes, or a billion bytes) describes the amount of data-storage space the computer has on its hard drive. This is memory that will remain intact even after the computer has been shut down. Many explanations of computers show simple block diagrams that look something like Figure 1.3.

So that PCs can be easily upgraded, PC manufacturers put empty electronic connectors inside each PC; most people call them *expansion slots*. The expansion slots are the easily visible part of the *bus*, which communicates with the CPU. Over the years, several bus types have become popular. The most common internal bus nowadays is Peripheral Component Interconnect (PCI). (Don't worry about this now—I'll take it up in detail in Chapter 2.) Most motherboards today have these PCI expansion slots; some also include another (older) type of bus, called Industry Standard Architecture (ISA). Figure 1.4 shows a motherboard with both of these kinds of slots. Fortunately, their designs make it impossible to plug an expansion card into the wrong type of socket. But you still need to know what types of cards your motherboard will accept before going out and buying that great video card upgrade!

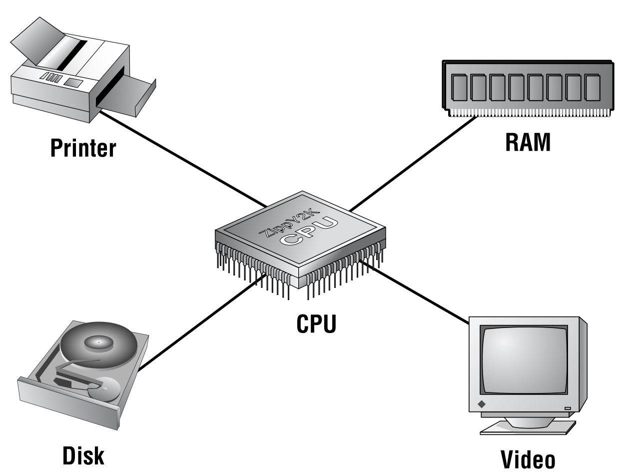


FIGURE 1.3
The CPU is logically connected through the motherboard to its memory, hard disk, video display, and printer.

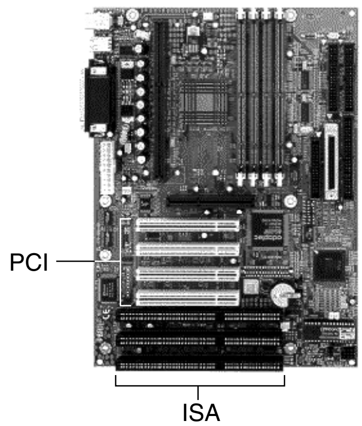


FIGURE 1.4
Notice the PCI and ISA expansion slots on this Pentium motherboard.

Why are there PCI and ISA bus connectors in this computer? Because they're both standards on which computer system designers and computer expansion board designers can agree. This is important because, just as the standard electrical sockets in your home's walls make it easy for you to buy appliances with electrical plugs and immediately use those appliances, a standard bus connector such as PCI or ISA means you can buy your PC from one vendor and your sound card, display board, or internal modem (to name just a few examples) from another vendor and still be pretty sure they'll work on your PC.

The mildly tentative tone of the previous sentence reflects that hardware compatibility in the PC world is sadly not a sure thing, and even the biggest names in the PC business sometimes sell hardware that just plain doesn't do what it's supposed to do. However, the industry is continually evolving, and few hardware incompatibility issues remain.

TIP One piece of trivia you might find helpful to remember: The newer the PC motherboard, the fewer the number of ISA devices that will be supported by it. Most new motherboards have no ISA connections at all. The ones that do just have one dual ISA/PCI slot along with lots of PCI slots. ISA was provided for many years for backward compatibility, but it's on its way out because of the prevalence of faster buses.

By now you might be wondering exactly *who* sets the standards for how PCs are designed. Sadly, the answer in most cases is that there are a lot of cooks in the kitchen, and that makes standards seem less than well, *standard*. Two of the most important cooks are Microsoft and Intel (sometimes referred to together as *Wintel*). Almost every year, the companies issue a set of design guidelines that spell out the minimum requirements that a PC must have to carry the label "Microsoft Windows compatible."

Although many current video boards connect to the CPU through a PCI interface, one of the main features that drives innovation in the computer business is speed: the faster the CPU and video controller can blast pictures onto the screen, the more popular the computer is likely to be. So when some in the industry became impatient with PCI's top speed (not fast enough!), Intel decided to add another bus—for graphics boards only—that the computer could use instead of PCI. This ushered in the Accelerated Graphics Port (AGP) standard. Thus, when you read an ad saying that a computer has AGP video, it means there's a connector inside the PC that's designed to offer higher speed than PCI, and the system uses an AGP-compatible video controller.

You've learned about CPUs, peripherals, controllers, and buses; now what about interfaces?

NOTE The first AGP controllers offered a speed of 1X or 2X, but the faster 8X controllers are now on the market, along with the motherboards that support them. The fastest AGP specification is currently version 3.0. The original AGPs weren't a lot faster than using a PCI video board, but using AGP video meant you freed up a PCI slot. The 8X refers to a much faster rate of transfer from the video to the CPU and back again, something that's finally helping to end some of the video-speed bottlenecks that most people have experienced.

Just as standard buses such as PCI make it easy for one vendor to offer a PC and another vendor to offer a disk controller, there's also a standard interface between the disk controller and the disk. For historical reasons, there's more than one way to connect a disk to a disk controller. The most common disk interface used today is the EIDE interface. EIDE is so popular, in fact, that virtually all motherboards have two EIDE controllers built right into them. Each EIDE controller can accommodate up to two EIDE drives (either hard drives or CD-ROM/DVD drives).

The EIDE standard for the past several years has been a parallel bus structure called Ultra ATA. Although it's been serviceable for most users, today's computers require faster data transfers to and from the hard disk. Because of the physical limitations of the Ultra ATA design, a newer standard called Serial ATA has been developed. It's fast and self-configuring, supports hot plugging, uses less power, and is easy to configure. I'll talk about more Serial ATA specifics in Chapter 10, "Understanding and Installing ATA Drives."

How are CPUs, buses, adapters, interfaces, and peripherals connected? Does one have to go with another? For example, will you find that SCSI adapters are available only for PCI? Not at all. As far as I know, SCSI adapters are available for every bus around, with the exception of AGP. Five easy pieces, then: CPUs, buses, controllers/adapters, interfaces, and peripherals. The CPU does the thinkin', the peripherals do the doin', and the controllers/adapters help them communicate. Buses and interfaces are just the glue that sticks them all together.

Actually, There's a Sixth Piece

Buying all of this hardware is of no value if you can't make it all work. As you probably know, computer hardware is of no value if there isn't *software* to control it. So, in a sense, there's a *sixth* piece to my five-piece model: software that's designed to control specific pieces of hardware. These pieces of software are called *drivers*.

The best hardware in the world is no good if your operating system and applications don't support it. The question of whether a particular piece of hardware has drivers for, say, Windows XP, Windows Millennium Edition (Me), Windows 2000, Windows Server 2003, or Linux is of vital importance when you're buying new hardware. Most newer operating systems offer formal or informal hardware compatibility lists—a roster of hardware directly supported by that operating system version. At the least, they'll have notes about devices known to have problems when used with that operating system. (Sometimes they include suggested workarounds, too.) You should find this information for your operating system before you shop for any new piece of hardware. Buying and trying unsupported hardware can make for a long walk down a lonely road—such hardware might work just as well as one that's supported, but it might also require a lot more work on your part. So check with your software vendor before falling in love with some new doodad.

NOTE You can access Microsoft's Windows Catalogs and Hardware Compatibility Lists for the entire family of Windows operating systems at `www.microsoft.com/whdc/hcl/default.mspx`. Older Microsoft operating systems had an HCL, but Windows XP, Windows Server 2003, and Windows 2000 use a more interactive Windows Catalog. It does the same thing that an HCL did, just better.

Real-World Advice

Make sure the hardware you buy is compatible with your operating system. If not, you could be in for a lot of headaches trying (and failing) to get your new hardware to work!

Typical PC Components and Issues

At this point, you might be thinking, "Yes, I've heard of Pentium 4, gigahertz, EIDE, and AGP, but that's not *all* I've heard of—what about BIOS, Ethernet, or FireWire connections?"

The intention of this chapter is to introduce you to several basic PC terms and help you start to organize the concepts of PC hardware in your mind—but first I needed to explain the five-part model. Now that you're comfortable (I hope!) with the terms *CPU*, *bus*, *adapter/controller*, *interface*, and *peripheral*, I can round out the chapter with five-second explanations of the most significant PC terms.

I'll discuss most of these terms again in greater detail later in this book. For now, though, Table 1.1 will serve as a good warm-up of terms you need to know.

What you see in Table 1.1 are PC features, a few common examples of each feature, and a brief bit of why you should care about each feature. Following the table, Figure 1.5 identifies some of the connectors you'll see on the back of your PC.

Table 1.1: PC Pieces

Feature	Typical Examples	Brief Description
AGP bus	Brown expansion slot on the motherboard for video adapters.	This bus is designed specifically for use with video boards.
Basic input/output system (BIOS) manufacturer	American Megatrends Incorporated (AMI), IBM, Compaq, Phoenix, Award.	BIOS is the most basic control software for your computer. The BIOS is what makes a PC IBM compatible. It tells the computer how to look at the bus, memory, and floppy drive and how to read other programs. The BIOS isn't a plug-in card; it's a chip that's mounted right on the motherboard.
Bus type	PCI, PCI Express, PC Card (formerly known as PCMCIA), CardBus, PC bus (8-bit ISA), AT bus (16-bit ISA), proprietary 32-bit, 16- or 32-bit Micro Channel Architecture (MCA), EISA, Local or VESA bus, AGP, FireWire.	The bus determines what kind of expansion circuit boards will work in the machine. As with a CPU, a major bus characteristic is speed. Boards built for one bus generally will not work on other buses, so the second main bus characteristic is compatibility. (Having a PC with the fastest bus in the world is no good if no one makes boards that work in that bus.) PC Card and CardBus are mainly used in laptops; most current desktops use PCI and AGP, but PCI Express is gaining popularity. You'll find that most controllers come in versions for any kind of bus.
Cache	256 kilobytes (KB), 512KB, 1 megabyte (MB).	RAM is slower than most CPUs, making memory speed an important system bottleneck. Faster memory exists, but it's expensive. PCs compromise by including just a small amount of faster memory, called *cache*. If it's on the motherboard, it's called level 2 (L2) cache. Many processors include their own cache, which is called level 1 (L1) cache.

TABLE 1.1: PC Pieces *(CONTINUED)*

FEATURE	TYPICAL EXAMPLES	BRIEF DESCRIPTION
Cartridge storage device	Iomega Jaz, Zip drives, Shark drives, Syquest drives, Castlewood Orb drives.	These work like hard disks but are usually a bit slower. Their main feature is that they're reasonably priced backup devices. Some attach to a parallel port, some to EIDE, and others to SCSI or USB.
CD-ROM drive speed, interface	EIDE, SCSI.	CDs are the basic means for distributing programs and data today. For less than $1/CD, a vendor can provide the equivalent of about 600 books of text. CD-ROM drives are the peripherals that make it possible to read those CDs. With a CD-ROM drive, speed is a relative thing. If you're using it to read text files or load software, a slower drive (around 16 by today's standards) will do. But if you're using it to play games, then you want the fastest CD-ROM drive you can get (52 plus).
CD recordable (CD-R)/CD rewritable (CD-RW) drive, also called CD burner	IDE, EIDE, SCSI, USB, FireWire.	A CD-R drive permits the one-time (recorder) writing of a CD, and a CD-RW drive permits the multiple (rewritable) writing of a CD. Both are usually used for data storage or writing a program or music for distribution. A CD can hold more than 720MB, but most CD-Rs write no more than 650MB (and CD-RWs even less, 440–550MB). These drives can also be used like a regular CD-ROM drive to install software and play audio CDs. USB versions are external and can easily be shared between multiple PCs (as long as all have at least one USB port).
Configuration method	Typically built into the system startup software.	Computers won't work until you tell them about themselves, or *configure* them—which you do by changing the BIOS configuration operation for your system. Today, virtually all computers configure themselves using built-in software in the BIOS. In some cases, you might need to set a few jumpers to configure CPU voltage levels, bus frequency, and cache memory on the motherboard.
CPU type	Pentium, Pentium Pro, Pentium II, Pentium III, Pentium 4, Celeron, Centrino, Itanium, K5, K6, Athlon, Duron, Alpha.	The CPU determines how much memory the system can address, what kind of software it can run, and how fast it can go. The main difference in modern processors is speed, but newer ones have other capabilities such as better graphics handling and multiprocessor support.
CPU speed	100 megahertz (MHz)–3.20 gigahertz (GHz) and getting faster every day!	MHz and GHz are rough measures of system speed. All other things being equal, a 1GHz processor would run twice as fast as a 500MHz processor. However, because so many other components affect the speed of your computer, doubling the CPU speed never actually doubles the system speed.

TABLE 1.1: PC Pieces *(CONTINUED)*

FEATURE	TYPICAL EXAMPLES	BRIEF DESCRIPTION
DVD drive	IDE, EIDE, SCSI, USB, FireWire.	As far as computers are concerned, a DVD drive is basically the next step after a CD-ROM drive. DVDs look like CDs, but DVDs can store more than 26 times as much data as CDs. DVDs can store as much as 17 gigabytes (GB), depending on the model drive and DVD you use.
DVD recordable (DVD-R) drives, also called DVD burners	DVD-R, DVD-RAM, DVD-RW, DVD+RW.	DVD-RAM drives are similar to CD-R drives but are for the higher capacity DVD format. DVD-RAM lets you record as much as 4.7GB of data per DVD side.
Floppy disks	5¼″: 1.2MB; 3½″: 1.44MB, 2.88MB (unusual); LS-120.	Floppy disks (also called floppies) are low-capacity removable media used to make your data portable. Today, because files are getting larger and larger, many computers aren't shipping with a floppy drive but instead with a Zip drive or some other high-capacity drive. The most common floppy drive today holds 1.44MB (just under a million and a half bytes) of data. Zip drives, by contrast, hold 100 or 250MB—about the same as hundreds of floppy disks. Floppies are driven by circuits called *floppy controllers*, and they interface with these controllers through a standard connector on a 34-pin ribbon cable.
Hard disk/ storage adapter	Advanced Technology Attachment (ATA)/IDE, Serial ATA (SATA), EIDE, SCSI.	The interface controller allows your computer to communicate with your hard drive, CD-ROM drive, and DVD drive. Most systems today use EIDE because it's inexpensive, easy to install, and fast. EIDE uses a 40-pin cable to interface with drives. The terms IDE and EIDE are often replaced by ATA in common terminology, but they're all the same. An ATA-33 drive with 33MB per second (MBps) throughput (simply put, how fast data moves to and from the drive) is the same as an Ultra DMA/33 drive, which is the same as an Ultra ATA/33 drive. ATA/100 drives offer 100MBps throughput, and the newer Serial ATA standard can transfer data at 150MBps.
IEEE 1394 (FireWire)	Typically available as a built-in port.	FireWire is a newer external bus standard that's much faster than traditional bus options, allowing for a maximum data transfer speed of more than 400Mbps (megabits per second). FireWire has many possible uses, but it seems to be most popular for connecting digital video cameras, where fast real-time transfer of huge amounts of digital data is necessary.
ISA bus	Older, black expansion slots on the motherboard.	Used for old expansion cards, including modems, sound cards, and port expanders (additional serial and parallel ports).

TABLE 1.1: PC Pieces *(CONTINUED)*

FEATURE	TYPICAL EXAMPLES	BRIEF DESCRIPTION
Keyboard	Various input typing devices.	Keyboards have a controller on the PC's main board, and most use either a mini-DIN (PS/2) or a USB. Some old keyboards use a full-sized DIN interface called an *AT-style connector*—a reference to the original IBM AT. Most new keyboards are compatible, and you have a choice about what kind of shape, color, size, and ergonomics you prefer.
Local Area Network (LAN) board	Ethernet, Token Ring, FDDI, ATM, Attached Resource Computer Network (ARCNet).	LANs allow PCs to communicate with each other and share data and printers. To do this, each PC on a LAN needs a network interface card (NIC). There are several types of NICs, including Ethernet, Token Ring, Fiber Distributed Data Interface (FDDI), and Asynchronous Transfer Mode (ATM). Ethernet is the most common. Most businesses have LANs, and more and more homes are adding LANs as they acquire two or more PCs. Home and small-business LANs are often *wireless*, which means that the LAN card connects to the network without cables—typically via radio frequency (RF) signals or your home phone line.
Memory (RAM)	64MB, 96MB, 128MB, 256MB, 512MB, 1024MB (1GB).	This is the workspace PC's use for the software they're currently processing. Newer software generally requires more RAM than older software.
Memory (RAM) type	Dynamic RAM (DRAM), Extended Data Out (EDO), synchronous DRAM (SDRAM), Rambus DRAM (RDRAM), Double Data Rate SDRAM (DDR SDRAM), DDR2.	Although RAM *is* slower than most CPUs, memory chip vendors have been working hard to try to bridge that gap. The fastest current kind of main memory is called SDRAM. It's preferable in new systems. Although traditional RAM operated at 100MHz, newer forms operate at 200MHz and faster to match faster motherboard clock speeds. RDRAM is a common standard, as is the less-expensive (but still fast) DDR SDRAM and DDR2. By the way, memory usually connects to the CPU through a proprietary bus, rather than PCI or some other standard.
Modem	300 baud, 9600 bits per second (bps), 33.6 kilobits per second (kbps), 56kbps.	Analog communications devices, allowing computers to connect to each other. Modem speeds are pretty much maxed out, and newer types of connections—such as a cable modem and digital subscriber line (DSL)—are now much more popular. It's estimated that over half of Internet users are using a high-speed connection as opposed to a modem. Five or ten years from now, modems may go the way of the 5¼″ floppy drive.
Mouse	A variety of rolling devices, including mice and rollerballs.	Designed to make computing easier by allowing people to "point and click." A key part of the Windows Icon Mouse Pointer (WIMP) interface.

TABLE 1.1: PC Pieces *(CONTINUED)*

FEATURE	TYPICAL EXAMPLES	BRIEF DESCRIPTION
Number of direct memory access (DMA) channels supported	4 or 8. (Only very old PCs have just four.)	Usually, the only thing talking to your memory is the CPU. Information stored in RAM is read by the CPU, and the CPU uses RAM to store information. However, some devices such as hard drives take a (relatively) long time to move data back and forth. And if the computer needs to act as the go-between for this data, the CPU can get bogged down in the process. DMA lets certain devices to communicate directly with RAM (main memory), allowing the CPU to attend to other processes while the hard drive, for instance, transfers data to RAM. Using DMA to handle data transfer between many of the external devices and RAM really improves the overall processing speed of your computer.
Number of expansion slots	3–10.	The more the merrier. Many big-name computers sport only three expansion slots. As the popularity of USB devices increases, expect to see fewer and fewer expansion slots.
Number of peripherals supported	8 or 16. (Only very old PCs have 8.)	For the computer to use its peripheral devices, it needs to know when a device has information for it. For example, if you press a key, the keyboard has to have a way to get that information to the computer. In the past, computers would get this information by *polling* their external devices (looking first at one device, then the next, and so on, repeating the process many times per second). The trouble is, this takes up a lot of computing time, and early microcomputers had little power to spare. So the engineers who developed the microcomputer changed to a new system that uses interrupts. Interrupts (also called interrupt requests—IRQs) are associated with the external devices. When a device has information for the computer, it signals the CPU through its interrupt line. The problem is, generally no two devices can share an interrupt. This means when you're configuring your system, you need to make sure you don't assign the same interrupt to two or more devices. Doing so will cause those devices to have a conflict and can make the system crash—or at least not recognize the devices.
Parallel port	Unidirectional, bidirectional, enhanced parallel port (EPP), and enhanced capabilities port (ECP).	The parallel port is the basic adapter for printers and external drives such as Zip and CD-R/RW drives. The interface uses a connector called a *Centronics connector* at the printer end and what's known as a *DB25 connector* on the computer end. In its simplest form, the parallel port is unidirectional—data goes from the computer to the printer and not the reverse. Most current parallel ports now also support bidirectional data flow—data can go back and forth between the computer and the parallel device—and higher data transmission speeds.

TABLE 1.1: PC Pieces *(CONTINUED)*

FEATURE	TYPICAL EXAMPLES	BRIEF DESCRIPTION
PCI bus	White expansion slots on the motherboard.	Used for a variety of peripherals, including video cards, sound cards, modems, and SCSI host adapters. A common standard today, it's gradually being phased out for the newer PCI Express.
Plug and Play (PnP) compatibility	PC systems are identified as being either PnP compatible or not. (Only ancient computers, called *legacy systems*, don't support PnP.)	PnP is a standard that allows a computer to automatically identify and configure devices you want to add to the system. To have PnP work, your BIOS and operating system must support it (most new ones do), and you must have PnP hardware. Also, a newer type of PnP, called *Universal PnP*, is available in Windows XP; Universal PnP extends the PnP concept to the network, enabling automatic discovery and control of network devices and services.
Printer control language	Epson codes, HPPCL (LaserJet commands), PostScript, others.	Printer control languages tell your printer how to underline words, put pictures on the page, and change typefaces.
Serial port	COM1, COM2, COM3, COM4.	Serial ports are adapters that support a wide variety of low-speed peripherals, including modems, serial mice, digital cameras, Personal Digital Assistants (PDAs) such as the Palm Pilot, and some kinds of scanners. They connect to peripherals using an interface called *RS-232*, which most commonly uses a male DB25 or DB9 connector. Generally regarded as old and slow.
Serial port Universal Asynchronous Receiver/Transmitter (UART)	8250, 16450, 16550, 16650, 16750, 16950.	The UART is the main chip around which a serial port or internal modem is built. The 16550 UART is no longer the fastest, but it's still commonly used for high-speed communications and communications in multitasking environments. Software supports fast serial ports through a first-in, first-out (FIFO) buffer. The 16550 UART offers 16-byte FIFO, the 16650 offers 32-byte FIFO, the 16750 offers 64-byte FIFO, and the 16950 offers 128-bit FIFO.
Sound card	8-bit, 16-bit, 32-bit, 64-bit, 128-bit, frequency modulation (FM), Musical Instrument Digital Interface (MIDI), wavetable audio interface.	Sound cards support music and sound reproduction on your PC, but music and sound are represented in an 8-bit, 16-bit, 32-bit, 64-bit, or 128-bit format. The 32-bit format is better, but it takes up more space. The sounds are recorded and reproduced either with FM synthesis, MIDI control, or wavetables. Additionally, with the right audio interface cable, a sound card in combination with the right software can play music on your PC. The newest sound cards even support Dolby 5.1, so you can watch your favorite movie using your computer's DVD drive and have the same heart-pounding sound you hear in the theater. The key for soundcard compatibility is the "Sound Blaster standard."

TABLE 1.1: PC Pieces *(CONTINUED)*

FEATURE	TYPICAL EXAMPLES	BRIEF DESCRIPTION
System clock/ calendar	Built-in on the motherboard or added on an expansion board on really old PCs.	The system clock keeps the proper time and date and is used to "clock" various system operations.
USB	Available as a built-in port or an add-on interface card.	This adapter was first introduced in 1995. It features both speed and flexibility; one USB interface can support up to 127 devices, including keyboards, mice, scanners, digital cameras, printers, and modems. USB adapters use a small proprietary connector as their interface to USB-compliant peripherals and can often be daisy chained together—although using multiple USB devices might require the use of one or more USB hubs (a central connectivity device). Virtually all new computer systems and all current operating systems now support the main USB standard. The current version of the standard—USB 2—is much faster (480Mbps versus USB1.1 at 12Mbps) and beats out SCSI and FireWire for drive throughput.
Video board	Video Graphics Array (VGA), SVGA, 8514 Adapter, Extended Graphics Array (XGA).	The video board determines how images are displayed on your monitor. This in turn affects what kind of software you can run and how quickly data can appear on the screen. Video boards vary in the number of colors and *pixels* (the dots on the screen) they can display. Most important in modern video boards, however, is whether they hold video data as a simple "dumb frame buffer," which requires that the CPU do all the video work, or they contain circuitry that can help with the grunt work of graphical screens. (Boards such as this are called *bitblitter* boards.) The main issues in video nowadays are speed, resolution, and color depth (the number of colors the system can display at one time). The interface between most video boards and their monitors is called an *analog RGB interface*, where RGB stands for *red, green,* and *blue*. Although some of the newer video boards interface with the new flat-panel displays with analog boards, more and more of the new flat-panel displays use a faster digital interface. Among today's fastest video boards are those including the 256-bit graphics-processing unit for optimum 3D graphics performance.

EXERTING YOUR GEEKINESS UPON OTHERS

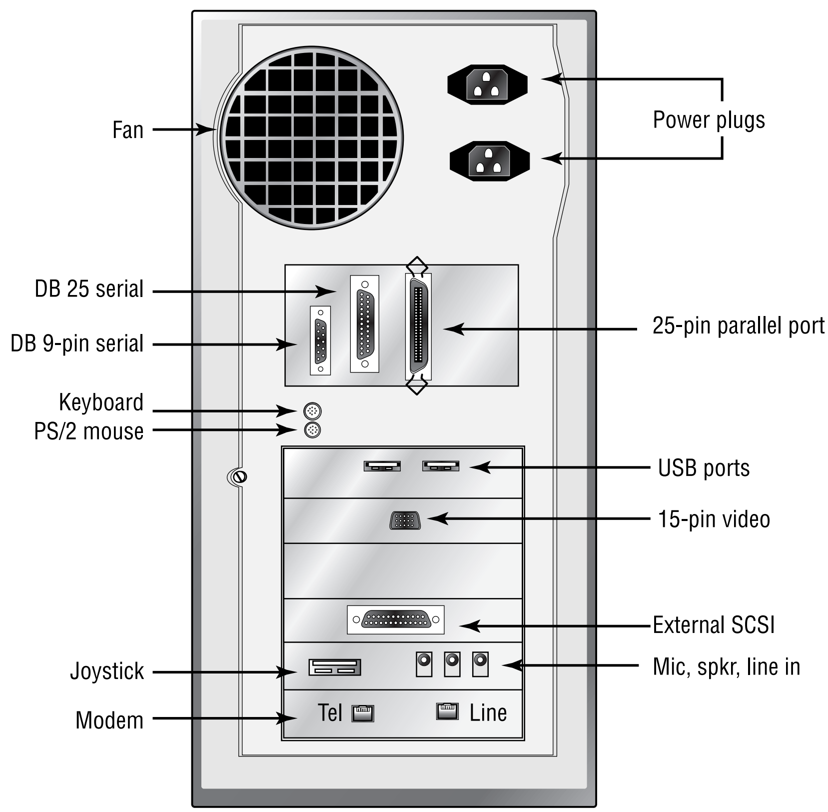
Okay, now you have some knowledge of the basics in terms of hardware connections and peripherals. The one constant in the computer industry is change, and quick change at that. Once you look up the newest and fastest hardware (or purchase it), it's basically obsolete. How does one possibly keep up with it all?

The answer is, you don't have to unless you want to. If your job is to fix computers or be the expert on how many millions of polygons a particular sound card can render per second, then it would probably behoove you to do your best to keep up by constantly scouring the Internet and trade journals for the latest and greatest. If, however, you want to be knowledgeable about hardware without devoting your life to memorizing specifications, that's fine, too. You can be knowledgeable without being obsessive.

Here's how: Make sure you have a firm, firm understanding of the basics of how computer hardware works. That's what this chapter, along with the rest of Part 1 of this book, teaches. Then, periodically take a look at the market to see what's out there. If the newest video cards have 512MB of RAM right now, they might have 1GB of RAM six months from now, but the fundamental technology will probably still be the same. At a minimum, the technology in terms of how the video card works in relation to the rest of the computer will be the same. You want to at least be able to have a decent conversation about computers (i.e., know the difference between a sound card and a video card, and know that an error about low memory means you need more RAM, not hard disk space), even if you don't know exactly how big the biggest hard drive is on the market.

Where knowing what the latest and greatest is becomes the most important is when you go to purchase hardware. Then, you really do need to know that you can get *X* performance for *X* price so you can make a good purchase decision. But you don't have to be a hardware junkie—unless you want to be.

FIGURE 1.5
The connectors you'll see on the back of your computer



Whew! Look like a lot of stuff? Well, of course, it *is* a lot of stuff! If there weren't a whole bunch of things to learn in PC hardware, this would be a pretty short book, right? But fear not, I promise I'll cover it all.

Now that the basics have been covered, it seems like it's a good time to dive into more details about the innards of your computer, starting with the core PC components described in Chapter 2.