An Overview of Computer Hardware

- Understanding how the CPU affects the computer
- Determining how RAM is measured and how it affects the speed of the computer
- Exploring common input devices
- Examining the most common output devices
- Understanding the most common storage devices

This paper provides an overview of the major hardware components used with Windows XP. In order to drive a car, you don’t need to know that air is inside the tires, that specific levers turn the heating on and off, or how to fasten a safety belt. Such is the case with computers. You don’t actually need to know everything in this section, but the more you know the safer and more enjoyable your computer experience will be.

Central Processing Unit: Chips and Systems

There are actually two parts of the computer that are often called the CPU, or central processing unit. The first is a chip inside the computer, the brains of the computer. Second, the case with its internal components is sometimes referred to as the CPU. You can generally tell which one a person is talking about by the context. For example, if asking about speed, the questioner is normally referring to the chip inside the case. If you are asked to bring the CPU in for repair, don’t try to remove the chip; just take in the case with its internal components. In this section, I use the term System Unit to refer to the case and its parts.

The Central Processing Unit chip

The Central Processing Unit (CPU) chip is the computational brains of the computer.
How fast your computer operates is partially a function of the CPU type and speed. CPU types include: 8086, 8088, 80286, 80386 (SX and DX), 80486 (SX and DX), and the Pentium. All these chip types are copyrighted by Intel (perhaps the most famous maker of computer chips). As other manufacturers, such as AMD and VIA (who produce the Cyrix chip), entered the market, the difference between chip types became more difficult for the layperson to understand. Each has its own advantages and disadvantages. If you are unsure of which CPU chip will best fill your needs, ask a professional. This may save you quite a bit of money. Another good source of information about CPUs is www.cpuscorecard.com

**System Unit (CPU)**

The CPU (also called the System Unit) is the term sometimes used for the case and its interior parts. The most important part of the System Unit is the motherboard (shown in Figure 1).

![Motherboard](image)

Figure 1  The motherboard acts as a conduit for moving data between RAM, the CPU, and input and output devices.

The motherboard (also called a system board) contains connections for the CPU, RAM, input and output devices, as well as many other devices. In addition to acting as a connection board for various devices, the motherboard also moves data between devices. How fast the data moves across the motherboard is called bus speed. Common current bus speeds range from 100 MHz to over 800 MHz. The faster the bus speed, the faster the data moves across the motherboard.

**Tip**
The easiest way to understand bus speed is to equate it with school buses. If you have 100 students to get to school, a bus holding 20 students will require five trips. A bus able to contain 50 students will only need to make two trips. A really large bus, capable of holding 100 students per trip can complete the task in a single trip (80 percent faster than the bus holding 20 students).

Random Access Memory (RAM)

Random Access Memory, commonly called RAM, is measured in megabytes (MB) or gigabytes (GB). (See the sidebar How Do You Measure Storage Space? later in this section for exact definitions.) While the computer is turned on, the operating system, application, file being used, and keystrokes are all held in RAM. Any time power is interrupted or the computer power is turned off, everything in RAM is deleted. RAM is often called volatile, meaning it can only store data while power is applied.

Windows XP is capable of multitasking, meaning it can run multiple applications at the same time. For example, you can be downloading a file from the Internet, listening to music, and working in a word processing program all at the same time. The more tasks you are trying to complete, the more RAM you need. RAM is relatively inexpensive, and you should purchase as much as possible. As a rule of thumb, additional RAM is much more important than the speed of the CPU. The more RAM, the faster your computer will run.

Input Devices

In order for data to get to RAM, it must first be created. There are multiple ways of creating and manipulating data in Windows XP. The most common ways of entering data into RAM is by using a keyboard or mouse. You can also use a scanner to input data, or even use a speech recognition program.

Keyboards

If you are like most computer users, you will input most data into the computer by using the keyboard. The keyboard and monitor, two of the most important components of a computer system, cause most of the health problems that computer users experience yet they are frequently accorded the least attention.

Keyboards come in a variety of shapes, sizes, costs, and even colors. They retail from about $3 to over $200. As is the case with most computer components (or entire systems, for that matter), you get what you pay for. An inexpensive keyboard has a mushy feel to the keys. When a key is pressed, the force required to press the key remains the same from the top of the keystroke until the key is depressed all the way. You can’t tell when the character has actually been entered, and pressing keys all the way to their stops causes wrist problems. An inexpensive keyboard is also lightweight, and slips around easily on your desktop, causing decreased productivity and increased frustration.

A good keyboard will weigh enough so that it doesn’t move around on your desk. The keys will have a definite click when they are partially depressed, indicating the character
has been registered. The clicking is often referred to as a tactile touch. Without a doubt, the highest-rated keyboards of all times are manufactured by Northgate. They are quite expensive, and are often too large to fit in a standard keyboard holder.

Another popular keyboard is the Microsoft Ergonomic keyboard. This keyboard splits the main keys into left and right hands, and then tilts them slightly so each line of keys runs lower toward the center and higher as the line approaches the outside of the keyboard. This keyboard is designed to place your hands in a more natural typing position, relieving some of the stress on your wrists. This keyboard is uncomfortable for most people at first, but after a few weeks of typing on it, most find it very comfortable.

**Tip**
If you input a lot of data, investing in a high-quality keyboard will be worth your while.

If you use the hunt-and-peck method of typing, the keyboard you use isn’t nearly as significant. You might also be less inclined to purchase a high-quality keyboard if you use your computer mostly for gaming.

### Mouse

The mouse acts as a pointing device to select various objects and, in some cases, initiates specific commands affecting an object. The standard mouse today has two buttons and often a scroll wheel. The left button is used to select objects. When instructions indicate clicking a mouse button, that always means to press and release the main mouse button (almost always the left button). Double-clicking is clicking the main mouse button twice quickly.

**Tip**
When double-clicking, you must keep the mouse totally still. Beginners have a tendency to click too hard, resulting in a slight mouse movement. The computer sees this as two separate clicks, rather than a double click. Double-clicking is a critical skill in Windows XP, as well as other Windows-based applications. To practice your mouse skills, choose Start-->Control Panel-->Printers and Other Hardware-->Mouse. Double-click the folder in the Double-click speed panel to toggle it between open and closed. You can adjust the speed to a slower rate if necessary.

When you point at an object on the screen and right-click the mouse (press and release the right mouse button), a shortcut menu (called a context menu) is displayed indicating most tasks that can be performed on that particular object. If some tasks are grayed out, that means they are not available at this time.
**Mousing for Southpaws**

Although many left-handed people use the mouse in the standard configuration, others are more comfortable resetting the mouse for left-handed use. To change your mouse, choose Start-->Control Panel-->Printers and Other Hardware-->Mouse. On the Buttons tab, in the Button Configuration panel, place a checkmark in the Switch primary and secondary mouse buttons options. This sets the main mouse button as the right one, and the left button as the shortcut button. From this point on, instructions to click, double-click, or click-and-drag should be done using the right mouse button. When told to right-click, press the left mouse button instead.

If you are sharing a computer with another user, you might want to remember to reset the mouse to its original settings. The right-handed user may not know the secret to mousing for southpaws.

The scroll button, if your mouse has one, is located between the two mouse buttons. You can roll it forward or backward. Rolling the button forward acts as if you are using the arrow on the vertical scroll bar. Rolling the button backward is the same as using the down arrow on the vertical scroll bar. Pressing and holding the scroll button displays a four-headed arrow. Moving the mouse in any direction moves the screen display in that direction. Releasing the scroll button returns the mouse to its regular functions. Double-clicking the scroll button locks the mouse in scroll mode. Moving the mouse scrolls the screen left, right, up, or down. To return the mouse to the point-and-click function, simply press the scroll button again.

Although there are many other forms of pointing devices, they won’t be discussed here. They represent a small fraction of pointing devices currently in use. For additional information, you might want to check the Internet for pointing device reviews, or ask friends for their opinions of these devices.

**Scanners**

Scanners are available in a variety of prices. In general, the higher the resolution (scanning dots-per-inch), the more expensive the scanner. Most scanners use the USB (Universal Serial Bus) on the back or front of your computer as the input connection. This is much faster than using the parallel or serial ports. Scanners are capable of inputting two distinct types of data: pictures and Optical Character Recognition (OCR).

**Scanning Pictures**

Most software included with the purchase of a scanner is only capable of scanning pictures. These can be actual photographs, line or clip art, or even pages of text. The catch with scanning text as a graphic is that it can only be edited by a graphics program. It is nearly impossible to change words or add or delete text.

**Optical Character Recognition**

Optical Character Recognition (OCR) is the function of taking text on paper and translating it into a format that can be integrated into a word processing program. This is most useful when you have a hard copy of a document, but cannot find the original word processing
file. Another use is if you have a handwritten document and need to have it entered into a word processing format. This feature is only available in high-end OCR programs.

**Tip**

You may find that a good OCR program is more expensive than your scanning hardware. I use OmniPage Pro from Caere. This is a multiaward-winning program that retails for about $600. If you are going to do a lot of text scanning, you might want to consider investing in an application of this quality.

### Speech Recognition

Instead of using the keyboard for inputting large amounts of text you may find it easier to use a speech recognition application. I like ScanSoft’s Dragon NaturallySpeaking. It has won many awards. The training time is short, and accuracy is high. I did find, however, that I needed to purchase a USB headset for an additional $100 to permit the high level of accuracy needed for entering large amounts of data. IBM also produces a highly rated speech recognition program, ViaVoice. Either application would be a good choice.

**Tip**

If you have a cold, or for any reason you don't sound like yourself, speech recognition programs may not work, since they haven't been trained to your new voice.

### Output Devices

Although the most commonly used output device is the monitor, video cards, printers, and speakers are also output devices used by the computer. In this section, we’ll take a brief look at all four.

### Monitors

In addition to the keyboard, the monitor can also affect your health. Buying an inexpensive monitor can result in eyestrain, headaches, and even stress-related symptoms. When you decide to purchase a monitor, you should take several factors into consideration. Monitor type, size, dot pitch, and screen resolution are four specifications that can have an effect on your eyes. Cost is generally a factor we will need to take into account. Since cost is a primary decision maker for most people, let’s take a look at it first.

### Cost

As with all other computer-related items, you get what you pay for. In general, you want to be wary of buying an entire computer system, as they usually include a low- to medium-quality monitor. If you are going to be using your computer only for e-mail, then the
monitor specifications probably won’t be very important to you. If you plan to spend a
good deal of time in front of the monitor, you need to carefully consider how much money
you can afford to spend, how you will be using the monitor, and the warranty available.

In most cases, magazines such as Consumer Reports have generally advised against
purchasing extended warranties. The fact is that in general most monitors are now
throwaway items. That is, it costs more to repair them than to buy a new, higher-quality
monitor. If the warranty is only for 1 year, you might want to consider buying a different
brand of monitor. Many monitors have a 3-year warranty, and in 3 years if your monitor
fails, you will probably want to buy a newer model anyway.

Another warranty consideration is the stability of the company offering the warranty.
What happens to your warranty if the company fails? If you buy it from a local retailer, will
it still be in business in 3 years? If your monitor fails, where do you have to take it (or ship
it) for repairs? What is the turnaround time (how long will you be without a monitor)?
Consider these questions when contemplating whether to buy an extended warranty.

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### How Minutes Turn into Hours

If this is your first computer, and you have little computer experience, you might want
to estimate the number of hours you will spend in front of your monitor and multiply it
by five or ten to get a more realistic estimate. If you have worked with computers
before, you might have a realistic idea of how much time you will spend at the
computer. Currently, I teach introductory courses, so many of my students have little
experience with computers. For most students, the more they use the computer, the
more they are entranced by the possibilities for using a computer. Even
grandparents, who have been “forced” by their grandchildren to learn about
computers so they can exchange e-mail (how many children know how to stamp a
letter today?), have been hooked by all the information they can find on the World
Wide Web. What begins as an occasional hobby to exchange e-mail can rapidly
develop into many hours per week: checking CNN or MSNBC for news, visiting
virtual museums, learning digital photography, tracking genealogy, trading
information about their particular hobby or hobbies, and (even for grandparents)
game playing.

Users tend to either love the computer or hate it. It can easily become an obsession,
destroying families and social relationships and affecting hygiene. Many psychiatrists
now consider obsession with computers to be a disease which must be carefully
treated.

Computers can be an addiction and, like alcohol, if they are affecting your life
(especially if others tell you they are, but you don’t believe them), if may be time to
seek professional help.
Monitor Types and Sizes

There are two basic types of monitors: Cathode Ray Tube (CRT) and Flat Panel. The CRT has been around for decades. The originals were monochromatic (single color), green or amber on the black background of the screen. CRTs look similar to a television set. Since they are less expensive, CRTs are currently more popular than Flat Panel monitors, which may be only a few inches thick. Each type has advantages and disadvantages. A CRT has a bigger footprint, that is, it takes up more space on your desktop. It is less expensive than a Flat Panel monitor of the same size. If you are going to be working mostly with video, including gaming, you may find a CRT the better choice. Flat Panel displays are not as crisp when video is displayed.

A Flat Panel monitor can be a big space saver on the desktop. Usually, they display a better quality of graphics (other than video). Because they are not as popular as the CRTs, the price for a Flat Panel has traditionally been high. However, due to recent changes in technology, Flat Panel monitor prices are falling quickly and will soon compete with CRTs.

How Big Is a Monitor?

Like television sets, monitor sizes are reported in diagonal inches. Today, the most common sizes of monitors are 15”, 17”, 19”, and 21”. Unlike TV sets, what is measured is not necessarily what you get. For example, depending on the quality of the CRT, a 17” monitor may have a viewable area between about 15.2” and 16.8”. This is due to the differing sizes of black borders around the edges of the screen. Before buying any CRT monitor, you should ask what the viewable area is. The viewing area is only a consideration when purchasing a CRT. The reported size and actual viewing area are the same in Flat Panel monitors.

Dot Pitch

Dot pitch is the distance between like-colored pixels on the monitor. Pixel is short for Picture Element. A pixel appears as a single dot that makes up a very small part of your screen image. Dot pitch is measured in millimeters. The lower the number, the clearer the picture will be. In the old days (for example, 5 years ago), dot pitch might be as high as .51mm. This resulted in a very fuzzy picture and many headaches for users. Today, any dot pitch larger than .28mm is unacceptable for most computer work. As the dot pitch decreases, the price rises, so you may have to make concessions to get just what you need.

Screen Resolution

Screen resolution is expressed as a matrix of dots. For example, the VGA resolution of 640x480 means 640 dots (pixels) across each of the 480 vertical lines. Other common measurements are 800x600 (SVGA), 1024x768 (XGA), 1280x1024 (SXGA), and 1600x1200 (UXGA). Screen resolution is a function of both the monitor and the video card. The higher the screen resolution, the clearer the picture. Each icon or window gets smaller as the screen resolution increases. As screen resolution increases, the dots that make up an icon or window are closer together, so the image itself shrinks. Higher resolutions are generally only used with larger monitors. The higher resolution means that more objects can fit on the screen, but if you have a small monitor, the screen objects may become so small that they are difficult to see.
Video Cards

Many motherboards come with a built-in video card. As with any object built into the motherboard, you must make sure that it can be disabled, and that a replacement can easily be inserted into one of the accessory slots. An inexpensive video card will do for most applications, but if you’re going to do a lot of gaming, computer-assisted drafting, or graphic manipulation, you probably need to replace the inexpensive card built into the motherboard (unless your machine came with a high-quality video card).

Nearly all video cards have extra on-board RAM. As the amount of RAM increases, so does the cost of the card. Most video cards today are installed in the internal Accelerated Graphics Port (AGP) slot. Before upgrading your video card, check the speed of your AGP slot (this is listed in the motherboard manual). Sample speeds include 2X, 4X, and 8X. The higher the number, the more expensive the card, but the result is a faster speed. High-end video cards have an on-board CPU, which is responsible for processing the graphics. An on-board CPU has two distinct advantages: The CPU is optimized for handling graphic data, and because the motherboard CPU doesn’t have to handle nearly as much data, it is free to do its work faster.

Printers

Today, printers come in three basic varieties: dot-matrix, ink jet, and laser. In this section, we look at each type.

Dot-Matrix Printers

With rapidly falling prices of ink jet printers several years ago, dot-matrix printers went out of fashion. Relative to ink jet printers, dot-matrix printers are noisy, slow, and produce a much lower-quality output. You cannot print quality graphics with dot-matrix printers. Dot-matrix printers make dots on the paper by slamming a print head containing a number of pins against a ribbon, transferring the resulting character to the paper. Given all these disadvantages, why would anyone buy a dot-matrix printer? There is only one real reason to buy a dot-matrix printer: It is the only printer type that can print multipart forms. In a business that uses multipart forms, the only choice is to have someone type the papers manually, or buy a dot-matrix printer. Epson, Okidata, and Panasonic are currently the big three manufacturers of dot-matrix printers.

Ink Jet Printers

Ink jet printers are affordable, quiet, and very popular. An ink jet printer propels droplets of ink directly onto paper. Today, almost all ink jet printers produce color, or at least have a color option. Ink jet printers generally use from one to four ink cartridges. Lower-end printers may have a single cartridge with three colors (cyan, magenta, and yellow); these produce a composite black that is often muddy. Most ink jet printers come with two cartridges: one black and a separate one for the other three colors. If any one of the colors runs out, the entire cartridge must be replaced. In a few high-end ink jet printers you may find four cartridges: one for black and one for each of the three basic colors.

The high cost for replacement ink cartridges in some low-priced ink jets can make the less-expensive model more costly in the long run. To compare color quality, be sure that
samples from different models are printed on the same kind of paper. Clay-coated and other specialty papers greatly improve the printed results, because they do not absorb the ink like regular copy paper, but they cost more. Ink and paper costs are ongoing expenses, which must be taken into consideration.

**Tip**
You will see many advertisements for kits to refill your ink jet cartridges. Although money-saving, most users have not had good results using these kits. One of the reasons for problems is that most kits only refill the cartridge with ink. The nozzles for spraying the ink on the page are not replaced and may become clogged.

**Laser Printers**
At the top of the home and small business line of printers are the laser printers. The speed and quality of laser printers are generally superior to the ink jet printers. Laser printers have two disadvantages. First, they tend to cost considerably more than similar ink jet printers, and in order to get color, you must purchase an extremely expensive printer. Rather than spraying ink on the paper, laser printers use a method of production similar to that of a copy machine. This results in a high-clarity document, even when using inexpensive copy machine paper.

Although the toner cartridges used in laser printers are more expensive than the cartridges used in ink jet printers, the toner cartridges print many more pages than the ink jet cartridges. The price per page when using a laser printer is generally much less than when using an ink jet printer, particularly if you are using color with the ink jet printer.

**Tip**
The toner cartridge for my Lexmark laser printer retails for over $350. It is rated at printing over 14,000 copies. Unlike refilling ink jet cartridges, you can purchase rebuilt toner cartridges for your laser printer. Rebuilt toner cartridges have all major internal components replaced with new ones and usually carry a warranty of 1 year. For my laser printer a rebuilt cartridge costs less than $100. If you buy from a local company, they may install it and clean your printer at no extra charge.

**Sound Cards and Speakers**
If you want to play games or listen to music on your computer, you will need a sound card and speakers. Today, sound cards are often built into the motherboard. The sound card and speakers that come with a purchased system are generally of low, but adequate quality. However, some users invest more in the sound system for their computer than they originally spent for the computer itself.

Some sound cards offer 3-D sound. Others offer theater-quality sound. Regardless of the quality of the sound card, inexpensive speakers defeat the purpose. Speaker size is not an indication of speaker quality. If you're going to invest a lot of money in a sound system, take a consultant with you who can help you purchase a system that fits your needs.
Storage Devices

As mentioned earlier, the operating system, application, document, and keystrokes are all held in RAM. When the computer is turned off, power to RAM is lost and any information in RAM is deleted. RAM is only temporary storage; there are several other devices that offer permanent storage. In this section I discuss popular storage devices. I begin with hard drives, followed by various removable devices.

How Do You Measure Storage Space?

Abbreviations for storage values can often be confusing. These references can be made to either RAM or permanent storage devices. The smallest amount you see is generally a kilobyte (K or KB). The K is equal to approximately 1000 bytes. A byte is the amount of space needed to hold one character such as the letter of the alphabet or a number. So a device able to hold 1 KB of data can hold approximately 1000 characters. In reality 1 KB is equal to 1024 characters. Although this is not terribly important to understand, it does explain why at higher values the numbers are not exact. One megabyte (MB) is equal to approximately 1 million characters. A gigabyte represents the storage capacity for 1000 million characters (a billion). Large computers have storage devices measured in terabytes (one trillion bytes) and next-generation storage devices will be measured in exabytes (1 quintillion (10 to the 18th power) bytes).

Hard Drives

Hard drives are almost always internal, although you can buy an external hard drive. Sizes range from megabytes to gigabytes. This is where all primary data should be stored. You should always create a backup of your data on removable storage and store it elsewhere. Compared to other drive types, hard drives are fast and reliable. Many users talk about what they will do if their hard drive fails. It's not a matter of if a hard drive will fail but when it will fail. So, always make sure your critical data is backed up.

Floppy Disks

Today, floppy disks fall into the category of a dime a dozen. Many computer superstores use them as loss leaders. You can buy a package of 10 for $10 with a $10 rebate. Each is capable of storing about 1.44 million characters. Floppy disks are vulnerable to damage and not acceptable as media for permanent storage. Because of their limited storage space, floppy disks are being phased out. With many new computer systems you must pay extra to get a floppy disk drive. They no longer come as standard components of a computer system.
**CD-ROM Drives**

All of the storage devices mentioned previously have stored data on magnetic media. CD-ROM drives store the data using optical technology. CD-ROMs can hold about an hour's worth of music or 750MB of data. CD-R discs can only be recorded on once. CD-RW disks can be recorded, erased, and recorded on again. Data can be added or deleted from these discs. You must have a CD-RW drive in order to write to this type of media. In bulk, the price of CD-R discs is not much more than floppy disks. CD-RW media is somewhat more expensive but still generally under a dollar per disc.

**Iomega Zip and Jaz Disks**

Another method of permanently storing data is by using Iomega's Zip and Jaz disks. These disks store up to 100MB and 2GB, respectively. In the past Iomega has had considerable problems with the physical drives and many users chose to seek other solutions. Although the drive problem seems to have been solved, the major disadvantage is the cost of the disks themselves. Computer systems often come with Zip drives to be used for backing up the system. Jaz drives (offering a larger capacity than the Zip drives) are no longer sold by Iomega but may be purchased through third-party sources.

**Tape Drives**

A primary purpose of tape drives is to back up your hard drives. Data stored on tape drives is generally compressed to save space. Tape drives can be slow and expensive. Although excellent for storing backup data, they are not considered a primary source for data storage. The main reason is that the files are stored sequentially on the tape, and to retrieve a file, the tape must be cycled from the beginning.

**Flash Drives**

Flash drives are generally about 2 inches long and less than an inch wide. They plug directly into a USB port and act exactly like a hard drive. The cost is relatively low (I paid $49 for my 128MB flash drive). For any Windows 2000 or Windows XP computer, no driver is needed. You just plug the drive into the USB port, and it acts exactly like another hard drive.

**Review**

This section has provided a brief introduction into the world of hardware. Changes in hardware technology and price occur very quickly; however, the basics don’t really change, and that’s what I’ve offered you here. You might want to get an introductory book on hardware if you plan to learn more about it. Knowing about hardware, and how to replace minor parts, can save you a lot of money in the long run.