Lesson 1–1 What Is a Computer?

Objectives

- Describe the four operations of computers.
- Contrast analog and digital computers.
- Explain why data and instructions for computers are coded as 0s and 1s.
- Identify three benefits of computers.
- Explain the hexadecimal system of displaying color.

As You Read

Sequence Information Use a sequence chart to help you organize the four operations of computers as you read the lesson.

Key Terms

- bit
- byte
- computer
- data
- hexadecimal value
- input
- output
- processing
- program
- storage

Computer Basics

A **computer** is a machine that changes information from one form into another by performing four basic actions. Those actions are input, processing, output, and storage. Together, these actions make up the information processing cycle. By following a set of instructions, called a program, the computer turns raw data into organized information that people can use. Creation of usable information is the primary benefit of computer technology. There are two kinds of computers:

- Analog computers measure data on a scale with many values. Think of the scales on a mercury thermometer or on the gas gauge of a car.
- Digital computers work with data that has a fixed value. They use data in digital, or number, form. The computers that run programs for playing games or searching the Internet are digital computers.

Input

Input is the raw information, or **data**, that is entered into a computer. This data can be as simple as letters and numbers or as complex as color photographs, videos, or songs. You input data by using a device such as a keyboard or digital camera.

Bits of Data Data is entered into a computer in a coded language. The building blocks of that language are units called **bits**. *Bit* is short for *b*inary dig*it*. Each bit is a number, or a digit. A bit can have only two possible values—0 or 1.

Bits into Bytes Every letter, number, or picture is entered into the computer as a combination of bits, or 0s and 1s. The bits are combined into groups of eight or more. Each group is called a **byte**. Each letter or number has a unique combination of bits. For instance, on most personal computers, the letter *A* is coded as 01000001. The number *1* is 00110001.

Even images are formed by combinations of bytes. Those combinations tell the computer what colors to display and where to put them.

Color can be represented by a three-byte combination where each byte represents the red, green, or blue (RGB) component of the displayed color. The intensity of each component is measured on a scale from 0 to 256 since there are 256 possible combinations of 1 or 0 in each group of eight bits. To represent a color, the three byte RGB codes are simplified into a 6-digit **hexadecimal** value where the first two digits represent the intensity of red, the second two are green, and the last two are blue.

A hexadecimal number has sixteen possible values, so the RGB values are assigned a number from 0 to 15. But since 10 through 15 are two digit numbers they are expressed with the letters A through F, where A equals 10 and F equals 15. In this way, the 256 possible combinations of each byte can be expressed in two digits. For example, the hexadecimal value for pure, intense red is FF0000 since red has highest intensity and both green and blue are at zero. The hexadecimal for white is FFFFFF, or complete intensity of all three colors, and black is 0000000.

Processing

The second step of the information processing cycle is called **processing**. In this step, the computer does something to the data.

Coded Instructions What the computer does depends on the instructions, or **program**, given to the computer. The instructions are also written in binary code, using combinations of 0s and 1s. They might tell the computer to add two numbers, or they might have the computer compare two numbers to see which is larger.

Speed of Processing Computers can process data very rapidly, performing millions of operations every second. The ability to process data with lightning speed is another reason computers are so valuable.

Connections

Math You ordinarily count using the decimal, or base 10, system. That system has 10 values, 0 through 9. You can express many numbers using those values by adding additional places—the 10s, the 100s, and so on. Each place is 10 times larger than the previous place. In a binary system, the quantity represented by each place is 2 times the previous quantity. In an 8-digit binary number, the places are the 1s, 2s, 4s, 8s, 16s, 32s, 64s, and 128s. The hexadecimal system is a base 16 system. The places for RGB code are the 1s and 16s. In the conversion from binary to hexadecimal, the first hexadecimal value is equal to the 1s, 2s, 4s, and 8s of the color's binary number.

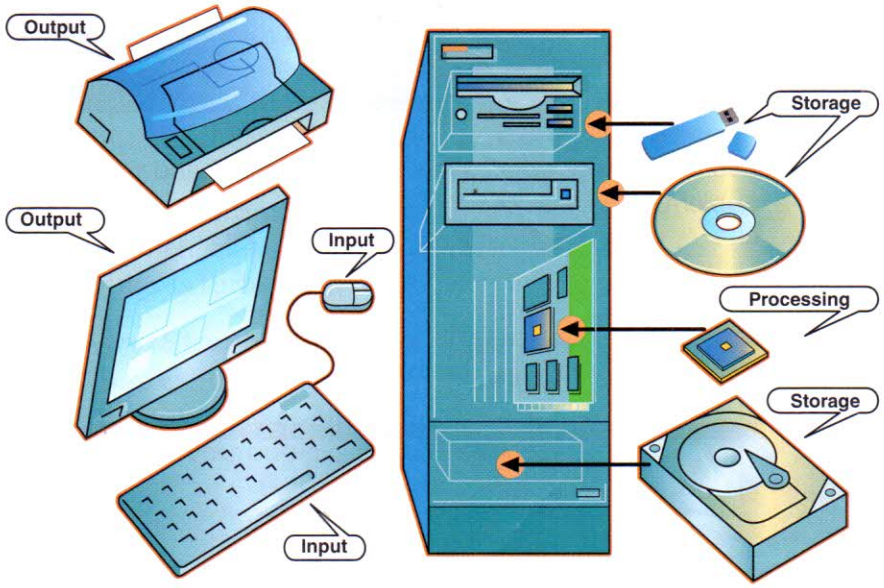


Figure 1.1.1 Each computer component plays a role in one of the system's four primary functions.

Technology @ School

In some schools, students' work is collected over the year in electronic portfolios. These portfolios reflect a range of the students' work on many projects during the school year. The computer's ability to store this information is perfect for portfolio work.

Think About It!

Think about how an electronic portfolio might be used. Highlight each item that you think could be in an electronic portfolio.

- multimedia presentations
- maps
- paper-and-pencil homework
- poetry
- lab report

Output

The third step shows what happens after the computer processes the data. This is the **output** step. If the program tells the computer to add two numbers, the output stage displays the result. To create output, the computer takes the bytes and turns them back into a form you can understand, such as an image on the screen or a printed document.

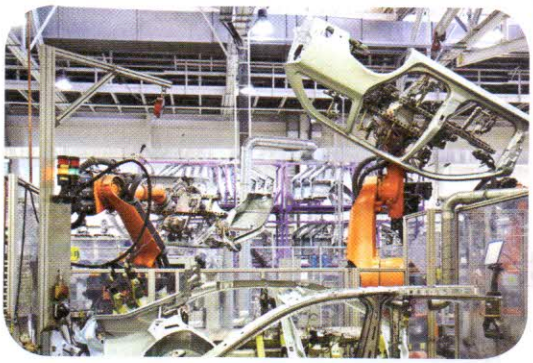
Output can take many forms. A program might convert the 0s and 1s into a report. It might become an image you are drawing on the computer. If you are playing a game, the output might be a car zooming along a road and the sound of its engine. A computer provides output through a device such as a monitor, speaker, or printer.

Storage

The fourth operation is **storage**, in which the computer saves the information. Without storage, all the work you do on the computer would be lost. Computers have a temporary memory that is used during the processing stage. When the computer is turned off, however, any data in that temporary memory is lost.

By storing the data in a permanent form, you can access the information over and over. This is another great advantage of computers—what you do one day can be saved and reused on another day.

Real-World Tech



Robots at Work Some output is very unusual. Computer-controlled robots work in some auto factories. Their output is cars. The robots are perfect for the tasks that take place on an assembly line. These tasks are done over and over again without change. For instance, robots weld parts together and paint car bodies.

What is a disadvantage to workers of bringing in robots to do tasks such as factory work? What can businesses and workers do to make that less of a problem?

What Is Computer Hardware?

Lesson 1–2

Objectives

- Summarize how a CPU and RAM work together.
- Contrast primary and secondary storage.
- Compare the features of four secondary storage devices.
- Identify three types of connectors and the peripherals that use each.

As You Read

Compare and Contrast Use a chart to help you compare and contrast computer hardware as you read.

What Is Hardware?

When you think about a computer, you probably picture its **hardware**, the computer's physical parts. You use hardware devices such as a keyboard or mouse to input data. The processor is a hardware **device** that turns the raw data into usable information. Hardware devices such as a monitor or a disk drive show output and store data for later access.

Inside the Case

Much of a computer's hardware is found inside the computer case, hidden from view. Most of this hardware is used for processing and storing data.

Processing Devices Perhaps the most important piece of hardware in a computer is the **central processing unit**, or **CPU**. This is the device that processes data. The CPU is a small, thin piece of silicon attached to a **circuit board**. The CPU is covered with tiny electrical **circuits**. By moving data along these circuits in specific ways, the CPU can do arithmetic and compare data very quickly.

Primary Storage Some hardware used to store data is inside the computer case near the CPU. The computer uses **random access memory**, or **RAM**, to store data and instructions while the computer is working. In this way, the CPU can quickly find the data it works with. This type of storage is called primary storage. RAM is volatile memory, which means data in RAM is lost when the computer is turned off.

Secondary Storage Devices Other pieces of storage hardware are secondary storage. The following devices let you store data permanently—even when the computer is turned off.

Key Terms

- central processing unit (CPU)
- circuit
- circuit board
- cloud storage
- device
- hardware
- peripheral
- random access memory (RAM)
- terabyte
- universal serial bus (USB)

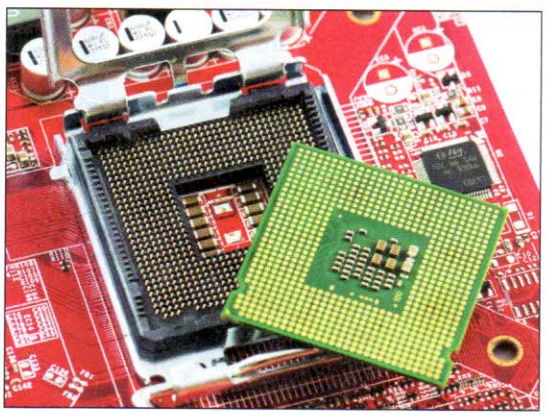


Figure 1.2.1 The CPU fits in a socket on a circuit board.

Service Technician Computer hardware sometimes fails. When that happens, people call service technicians. These people work for computer companies. They might work in the offices of the company that employs them, or they might travel to business sites to fix machines. Technicians need to know about software and hardware because problems are sometimes caused by a computer's programs and not by its equipment.

- Hard drives use a stack of disk platters to store large amounts of information permanently on the computer. External hard drives, which are plugged into the computer, are used to store back-ups of your data. They can be desktop or portable devices. They usually connect to the computer via a **universal serial bus**, or **USB**, port.
- Flash, jump, thumb, or pen drives—all names for the same kind of storage device—connect to the computer through a USB port. They hold anywhere from 4 gigabytes to as many as 32 gigabytes or more.
- Compact Discs (CDs), Digital Video Discs (DVDs), and Blu-ray Discs (BDs) are optical storage devices. You insert the CD or DVD into your computer through the disc drive. A CD can store 650 to 700 megabytes of data. DVDs can store anywhere from 4.7 gigabytes to double that amount if the DVD is double-sided. Blu-ray Discs hold from 25 gigabytes to 128 gigabytes.
- **"Cloud" storage** is online storage offered on various Web sites. Most of them will give you a few gigabytes for free, but then require you to pay for more space.
- Memory cards store data for mobile devices like smart phones and digital cameras. Some memory cards can store 256 gigabytes.

Secondary Storage Capacity Hard disk drives hold the most data. Many computers now have hard drives that can store several hundred gigabytes. A gigabyte is just over a billion bytes. Some external hard drives can store more than 30 **terabytes** (tb). A terabyte is about 1,000 gigabytes. Thumb or flash drives hold the next largest amount of data, sometimes going over 128 gigabytes. CDs and DVDs hold the least amount of data—from around 700 megabytes to almost 10 gigabytes. A megabyte is just over a million bytes, but still several hundred of them on a CD can store entire encyclopedias, including images, maps, and sound.

Figure 1.2.2 Today, nearly all computers feature a built-in hard drive. Some have capacities of 4 terabytes or more. Some external hard drives are able to store 30 terabytes of data.

Peripherals

For most desktop systems, input devices, such as the keyboard and mouse, are separate from the case. So are output devices, such as monitors and printers. Hardware that is separate but can be connected to the case is called a **peripheral**.

Not all computers have all this equipment as peripherals. Apple's iMac® computers include the monitor as a physical part of the main system. Other computers may have built-in storage devices. Portable computers have the keyboard, a type of mouse, and a monitor all attached to the main unit.

Peripherals need to be connected to the computer so that data can be moved back and forth. Some use a wireless connection and some are linked to the computer by a cable. Both wireless connections and cables connect to the computer with a plug. Most plugs join the computer at a connector on the computer case, but some are installed internally. Connectors can be unique for the peripheral. Monitors have specific plugs designed for transferring image data. Speakers and microphones have unique plugs as well. Many devices such as keyboards, printers, and mice use USB ports.

Connectors There are several main types of connectors, or ports:

- Serial ports move data one bit at a time. For example, they connect computers to modems for Internet access.
- Parallel ports move data in groups.
- Multiple device ports, such as Small Computer Systems Interface (SCSI) and Universal Serial Bus (USB) ports, connect several peripherals to a computer at one time. They all move data faster than serial ports can.

Did You Know?

One problem with computer hardware is the tangle of cables that can result from lots of peripherals. Bluetooth™ is a wireless way of communicating that uses radio waves to communicate between electronic devices.

Many cell phones and other portable devices use Bluetooth to send signals to each other. For example, many people use Bluetooth to send photos from their cell phones to their computers. These users may also use Bluetooth to send commands from their telephones and computers to DVD players, data video recorders, refrigerators, and other computer- controlled appliances.

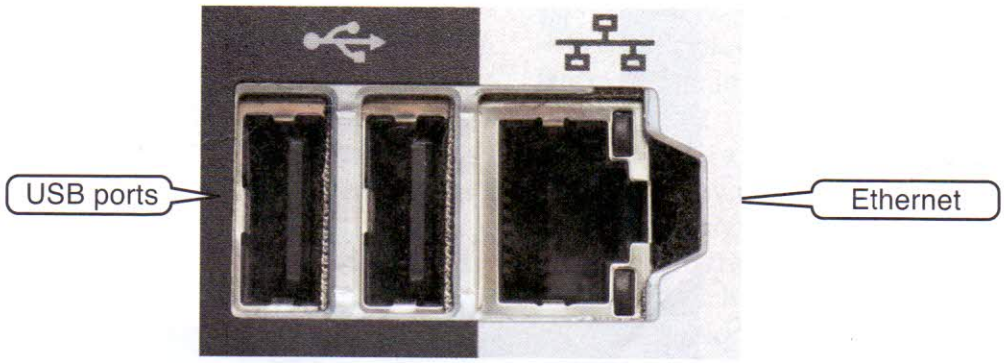


Figure 1.2.3 Ports are usually labeled, making it easy to know what plugs in where.

Lesson 1–3

What Is Computer Software?

Objectives

- Describe what an operating system does.
- Explain what utility software does.
- Identify four types of application software and ways to obtain them.

As You Read

Classify Information Use a concept web to help you classify different types of computer software as you read.

Key Terms

- application software
- operating system (OS)
- software
- system software
- utility software

What Is Software?

Hardware includes all the physical pieces that make up a computer. Hardware is useless without software, however. **Software** includes all of the programs that tell a computer what to do and how to do it. Think of a computer as a sports team. Hardware is the players, and software is the coach. No matter how talented the players are, the team will only perform properly if the coach gives it the right instructions.

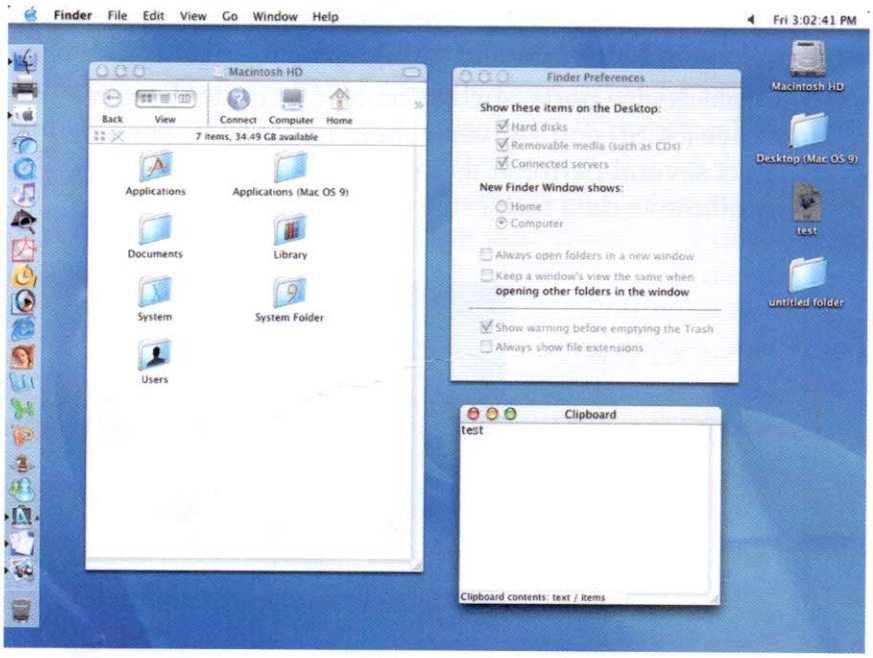


Figure 1.3.1 MacOS™, which runs Apple computers, is an example of system software.

Types of Software

Software is divided into two main types: system software and application software. **System software** includes programs that help the computer work properly. You are probably more familiar with **application software**, which are programs designed to help you do tasks such as writing a paper or making a graph. This type of software also includes programs that allow you to use the computer to listen to music or play games.

System Software

There are two types of system software: operating systems and system utilities. Both help computers run smoothly.

Operating Systems The **operating system (OS)** lets the hardware devices communicate with one another and keeps them running efficiently. It also supports the hardware when applications programs are running. The two most widely used operating systems are the Macintosh® OS and Microsoft® Windows®.

System Utilities Programs that help the computer work properly are called **utility software**. They usually do maintenance and repair jobs that the operating system cannot do itself. Some utility programs repair damaged data files or save files in certain ways so they take up less space. Others translate files created in one OS so they can be read and worked on in another.

Did You Know?

One key to processor speed is its clock speed, the rhythm at which the processor works. Clock speed is measured in hertz (Hz). A Hz is a unit of frequency equal to one cycle per second. Most processor clock speeds are measured in Gigahertz (GHz). 1 GHz equals one billion cycles per second.

Clock speed is not the only thing to consider when you select a processor, however. Speed is also influenced by factors such as the amount of RAM, clock speed of the RAM, and the size of the cache.

Spotlight on...

BILL GATES

"Bill Gates has the obsessive drive of a [computer] hacker working on a tough technical dilemma, yet [he also] has an uncanny grasp of the marketplace, as well as a firm conviction of what the future will be like and what he should do about it."

Steven Levy
Writer

Bill Gates has a simple idea about the future of computing. "The goal," he says, "is information at your fingertips." It will not surprise anyone if Gates and his company, Microsoft, play a major role in making that goal become a reality. Gates started writing software in high school. He and a childhood friend, Paul Allen, wrote a programming language to run on a machine called the Altair, the first personal computer. Allen and Gates then formed Microsoft, which is now one of the leading software companies in the world.

Technology @ Work

A software program's version is usually indicated by a number, such as "Version 4" or "Version 8.5." Software is upgraded to remove programming errors and to add new features. Some revisions are major, and the version number jumps from, for example, 9.0 to 10. Minor fixes typically change the number after the decimal point, such as 10 to 10.2.

Think About It!

For which items below would it be worthwhile for you to buy the new version of the program?

- a program you use all the time that is moving from 4.3 to 5.0
- a program you rarely use that is moving from 2.2 to 2.3
- a program you often use that is moving from 5.1 to 5.2
- a program you often use that is moving from 1.0 to 3.0

Application Software

There are many different applications. They can be grouped into four main categories:

- Productivity software helps people be more productive at work. People use these programs to write reports, prepare financial plans, and organize data.
- Graphics software makes it possible to draw, paint, and touch up photos.
- Communication software allows computers to connect to the Internet and to send e-mail.
- Home, education, and entertainment software helps people manage their money or figure their taxes. Other products can be used to learn new skills or simply to have some fun.

Custom Software There are two ways to obtain application software. Some organizations need software programs to do very specific jobs. They hire people to write custom software designed to do those jobs. Because these programs are custom written, they are usually quite expensive.

Off-the-Shelf Software Most people use software to do standard jobs. They might want to write letters or organize an album of photos. They can choose from many ready-made programs to handle these common tasks. These are called "off-the-shelf" programs because stores and companies that sell software online stock them. Most off-the-shelf software purchased online can be downloaded directly onto the buyer's computer. Because software publishers can sell many copies of this software, it is less expensive than custom software.

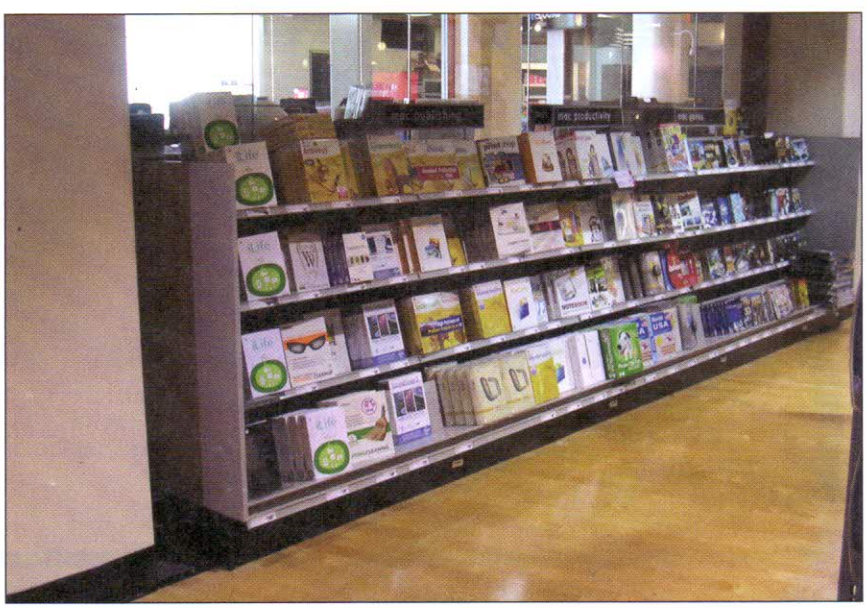


Figure 1.3.2 You can buy off-the-shelf software from a bricks-and-mortar store or online from a retail Web site.

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

e 1. input
h 2. bit
b 3. byte
j 4. output
d 5. hardware
g 6. central processing unit
c 7. random access memory
i 8. peripheral
a 9. software
f 10. utility software

a. program that tells the computer what to do
b. group of 8 bits
c. area where data and instructions are stored while the computer is working
d. physical parts of a computer
e. raw data entered into a computer
f. program that does maintenance or repair tasks
g. part of a computer that processes data
h. basic unit of data a digital computer can understand
i. hardware separate but connected to the computer
j. the results of the computer's processing

Check Your Comprehension

Directions: *Complete each sentence with information from the chapter.*

1. A(n) Computer is a machine that changes information from one form into another.
2. Processing is a basic operation of computers.
3. Data and instructions in computers are coded with a(n) A Binary Code because computers only understand two values.
4. The CPU uses Circuits to hold data it is working on.
5. Data in RAM is Lost when the computer is turned off.
6. A(n) Serial Ports is an example of a connector that works with only one kind of peripheral.
7. SCSI and USB connectors connect several peripherals at the same time.
8. Some organizations need communication software programs to do very specific jobs.
9. Communication software is used to connect to the Internet and send e-mail.
10. Off-the-shelf software is less expensive than custom software because publishers sell more units.

Think Critically

Directions: *Answer the following questions.*

1. How do analog and digital computers differ?

2. What is the RGB hexadecimal value for a pure intense green? Explain your answer.

3. What are the differences between primary and secondary storage?

4. What is the difference between system software and application software? Give at least one example of each.

5. What type of application software do you use most? Explain.

Extend Your Knowledge

Directions: *Choose and complete one of the following projects.*

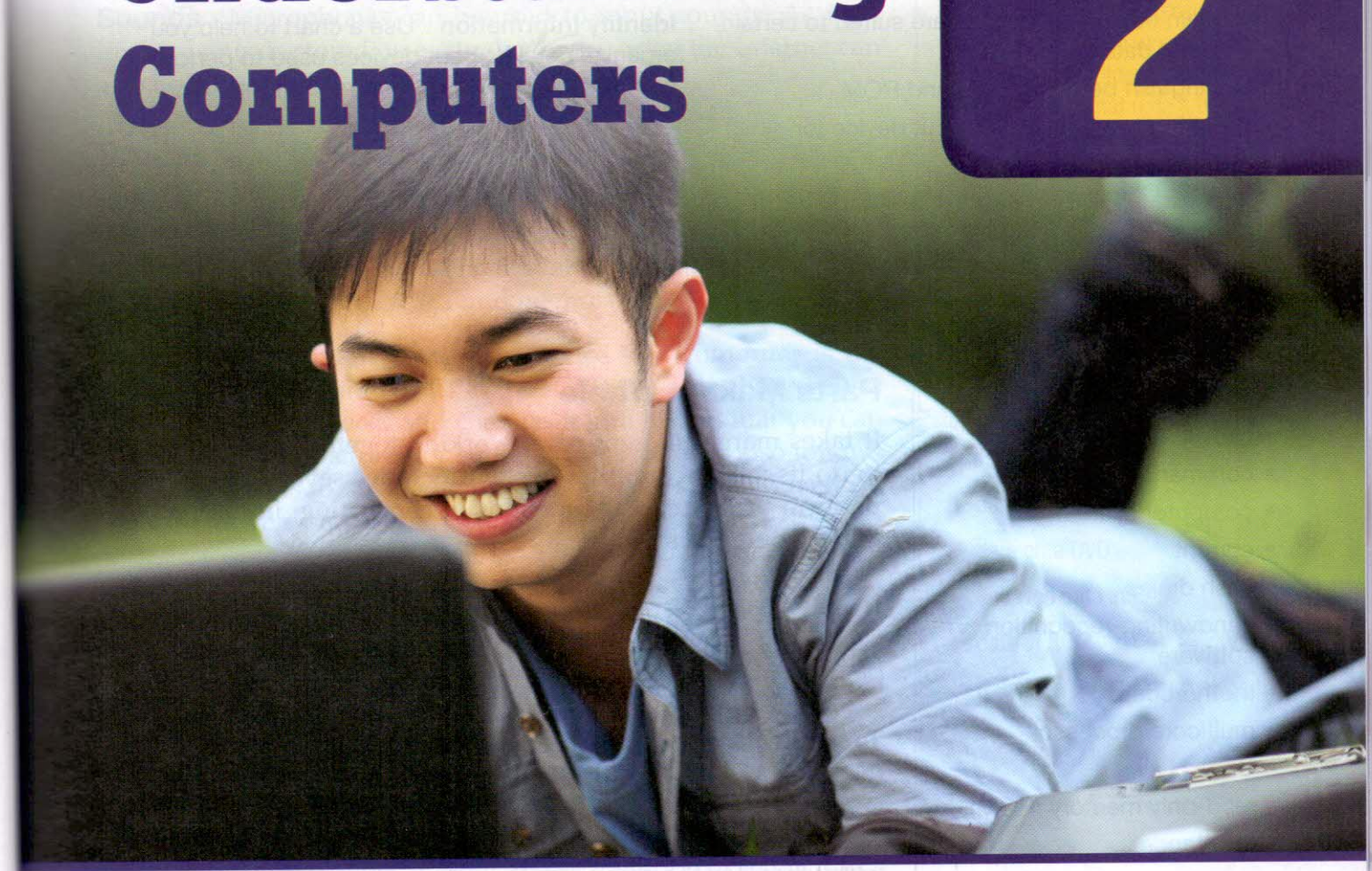
A. Look at a computer. Create a five-column chart. In the first column, list all the hardware that you can identify. In the remaining columns, state whether each item is used for inputting, processing, outputting, or storage. Examine how the different pieces are connected to the computer. What other hardware do you think the computer has that you cannot see? With your teacher's permission, unplug and replug all of the computer components, including external drives, a printer, mouse, keyboard, monitor, projector, and the power supply. Start the system. Record your observations. Discuss your findings with the class.

B. Using the Internet or library resources, research at least three types of processing devices used in laptop computers. Keep track of your sources. Create a chart that compares and contrasts the price, top speed, and number of operations per second each one can perform. Determine which device would be most appropriate for working with text, graphics, and math. Write a brief summary explaining your findings, including a list of sources or bibliography. Read your summary out loud to a partner and listen as your partner reads his or hers out loud to you.

chapter

2

Understanding Computers



Working Together Computers come in many different shapes and sizes. Some are large enough to fill a room. Others can be held in the palm of your hand. Whatever their size and capabilities, all these computers have something in common. They use electronic parts and instructions to perform specific tasks,

The electronic parts or components are called hardware. Hardware includes things like computer chips, circuit boards, hard drives, keyboards, monitors, and speakers. These hardware pieces, however, cannot perform the tasks by themselves. They require power and instructions. Electricity provides the power and software provides the instructions to work. Software programs unlock the potential of the hardware so that you can use the computer to do amazing things.

Chapter Outline

Lesson 2–1

Exploring Computer Systems

Lesson 2–2

Basic Programming Concepts

Lesson 2–3

Group and Individual Computing

Lesson 2–1

Exploring Computer Systems

Objectives

- Explain how input devices are suited to certain kinds of data.
- Distinguish between RAM and ROM.
- Identify an appropriate output device for different types of data.
- Explain Ohm's Law and its effect on electricity in a circuit.
- Summarize the tasks of operating systems.
- Identify two leading operating systems and explain why compatibility is an issue.

As You Read

Identify Information Use a chart to help you organize details about devices used to perform computing functions as you read the lesson.

Key Terms

- circuit
- command
- computer system
- current
- flash drives
- handwriting-recognition software
- motherboard
- multicore processor
- Ohm's Law
- read-only memory (ROM)
- resistance
- screen-magnifier software
- speech-recognition software
- stylus
- transformer
- transistors
- voltage

Parts Make a Whole

It takes many different parts working together for a computer to do its job. A **computer system** includes several devices that perform the four basic functions of computing: input, processing, output, and storage.

Input Devices

Input means entering data, such as text, images, or sounds. Computer users can choose from several different input devices.

Text and Commands Perhaps the most basic input device is the keyboard. You can type on it to input text (letters, numbers, and symbols) and commands. Keyboards may be localized for a specific language, such as Arabic or Chinese. A **command** is an instruction for the computer to perform some action. For example, the Print command tells the computer to send the file you are working on to a printer. With **speech-recognition software**, users can input text by speaking into a microphone, and with **handwriting-recognition software**, users can input text by writing with a **stylus** directly on a device such as a tablet or screen. The software changes the words into digital data the computer can read. This software can be used by people with disabilities that prevent them from typing.

A mouse moves a pointer on the monitor, which allows you to move around a document, or to select commands. Some individuals cannot use a mouse. For them, keyboard equivalents for mouse commands provide access to the data. Adaptive devices can help users type without using their fingers on the keyboard.

A trackball, touchpad, or trackpad function similarly to a mouse. Touch screens let you input some commands by touching the monitor directly. There are also motion-recognition software programs that let you input some commands by moving your hand across the display or by looking at a location on the screen. A joystick, often used in computer games, is yet another input device.

Images A mouse or stylus can also be used to input images by drawing in a graphics program. You can also input images using a digital camera or scanner, by importing them from a storage device or smart phone, or by downloading them from the Internet.

Sounds Microphones can be used to input sounds. As with images, sounds stored on a storage device or on the Internet can also be brought into the computer as input.

Processing Devices

Inside the computer, data travels from one device to another through the computer's **motherboard**. This board is covered with electrical circuits and switches, and it connects vital pieces of hardware such as the CPU and memory.

The CPU The main processing device in a computer is the central processing unit, or CPU. The CPU is a chip that receives data from input devices and changes it into a form that you can use, such as text, pictures, or sounds. The processor also follows your commands to do something to that data, such as change a word or move a picture.

CPUs can carry out fewer than 1,000 instructions. However, they can perform millions of these operations every second. That ability is what makes computers able to work so quickly.

Multicore processors have two or more CPUS so can process data faster. Most personal computers have at least a dual core processor (two CPUs), and some have quad core processors (four CPUs). The more cores on the CPU, the higher the price. But, the improved processing speed is probably worth it.

RAM The CPU temporarily stores the instructions and data it is using on chips called random access memory, or RAM. Once the computer is turned off, RAM no longer stores any data. Reading information from RAM takes very little time—just billionths of a second. Because programs today are complex, they need a large amount of RAM to run properly.

ROM A second kind of memory is called **read-only memory**, or **ROM**. These chips contain the instructions that start the computer when you turn it on. The instructions in ROM typically do not change once this memory is placed on the motherboard.

CPU vs. RAM vs. Hard Disk Factors that impact computer performance include processing speed, memory speed and size, and storage device speed and size. Most important, however, is how well these three components work together. Even if you have the fastest, most-efficient CPU available, it cannot process data quickly if there is not enough RAM available. If there is not enough RAM to hold the data, the CPU is forced to keep accessing the disk. As a result, the computer can only perform as fast as the disk drive.

Technology @ Home

A sudden loss of power that shuts down a computer may result in the loss of unsaved work. Users can prevent that loss by buying a backup device that runs a battery if the power shuts down. The battery can keep the computer running for 20 to 45 minutes, which gives the user enough time to save valuable data.

Think About It!

Think about what would be harmed by a loss of power. Which kinds of data listed below would suffer from a loss of power?

- data on a hard drive
- data on a DVD
- unsaved data in RAM
- data in ROM
- data on a CD-ROM encyclopedia

Figure 2.1.1 The motherboard houses all the chips and circuits a computer needs in order to function.

Technology @ Work

Purchasing and maintaining a computer system is costly for both individuals and companies. It is important to research all available options to make sure the investment will pay off in terms of productivity, ease of use, and efficiency.

Think About It!

Although the decision-making process is similar for both individuals and companies, there are some differences. Which of the following factors do you think is more important for an individual or for an organization?

- How much does it cost?
- Is it easy to use?
- Does it work with existing software and hardware?
- Does it meet current needs ?
- Will it meet future needs?
- Is it expandable?
- Is it easy to maintain?
- Is it durable?

Output Devices

Output is the results of the computer's processing. The output that users see or hear can lead them to give the computer new instructions for processing their data.

A computer needs output devices to display the results of its processing. Text and images are displayed on a computer screen. They can also be printed by a printer. Sound data is sent to speakers inside, or connected to, the computer. You can also connect headphones to a computer to listen to sounds. Some output devices and features help make computers more accessible to users with disabilities.

Monitors Both text and images are displayed on the monitor. Screen-magnifier software can make images on the monitor much larger for people who have difficulty seeing. The program enlarges the area where the cursor is. The user can also change the colors on the monitor to make text easier to see.

Printers Another form of output for text and images is print. A high-quality output at a large font size may help some people with poor vision read printed text more easily. Braille printers can also provide output in a format some people with visual disabilities can read.

Speakers To hear recorded voices, sounds, and music, you need external speakers or headphones. Software lets you choose which recording to hear and adjust the volume. Windows has a feature called Show Sounds. When activated, this feature shows a visual symbol when it plays a sound and displays spoken words as text. This feature can help people who have hearing difficulties. Many programs can display audio as printed text so people with hearing difficulties can see the spoken words.

Figure 2.1.2 Headphones let you hear sounds output from the computer.

Storage Devices

Because memory is temporary, a computer needs a secondary location for storing data permanently. Devices such as hard disk drives, **flash drives**, CDs/DVDs, and online storage are all popular types of secondary storage.

Electricity Powers the Computer

All computer components are powered by electricity. When you plug the computer into an outlet, the electricity flows from the outlet to the **circuits** of the computer. A circuit is network of electronic components. The computer circuits contain switches, or **transistors**, that use the electricity to complete tasks.

But how does the electricity get to your house? Power companies send electricity from a power plant to your house through power lines. Before the electricity goes into your house it travels into a **transformer**, which is a device that transfers electricity from one circuit to another. Wires, called windings, in the transformer lower the **voltage**, or electric pressure, of the electricity before it reaches your house.

The electricity flowing through your computer behaves in a constant fashion and follows scientific rules. **Ohm's Law** is a rule that describes how electricity will behave as it travels through circuits. Ohm's Law says that the **current**, or flow of electricity, through a wire is directly proportional to the voltage pushing electricity through the wire. Think of water moving through pipes. If you increase the pressure in the pipes, the water moves faster. Electricity acts in the same way. If you increase the voltage, the current moves faster.

Electronics in your house do not use a constant flow of electricity, called **direct current (DC)**. Instead, they use an **alternating current (AC)**. With AC current, the electricity briefly travels in one direction and then reverses direction. The back and forth happens very rapidly: over 50 times a second! Computers plug into the same type of AC outlet that other appliances use, but once the current reaches the computer's power supply it is converted to DC. That's because the internal computer components require DC.

Ohm's law also says that if there is more **resistance** in a wire, the current will move more slowly. Resistance is caused by anything that obstructs or inhibits current. Think about when you have a clog in your pipe: the water pressure is still the same but less water can flow through. There are many different types of conductors, or materials that electricity flows through, and each creates a different amount of resistance. Length and width of wires can affect resistance, as well. Resistance can be added to a circuit by using different materials or changing the thickness of the wires. Devices that add resistance to a circuit are called resistors. Computers use the relationship between voltage, resistance, and current in a circuit to control either the voltage or the current through the different components.

Connections

Math Ohm's Law can be summarized in the math equation:

$$V = IR.$$

This equation states that the voltage (V) equals current (I) multiplied by resistance (R). If you had a constant voltage but increased the resistance, the current would decrease. The equation shows that there is a direct relationship between voltage and current and an inverse relationship between current and resistance. Because this relationship is constant, it is possible to adjust one variable within the circuit by controlling the other two.

Give it a try: if you had a circuit with a voltage of 6 and a resistance of 2 what would the current be? The measurements for voltage is volts, resistance is ohms, and current is amps. Now what would happen if you kept the voltage at 6 volts but then changed the resistance to 3 ohms?

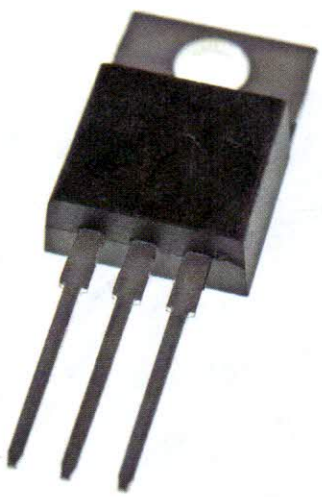


Figure 2.1.3 In transistors, three terminals are connected to an external circuit. Altering the current in one terminal changes the current in the other two. Many transistors together make up the integrated circuits used in modern electronics.

Did You Know?

A digital multimeter (DMM) is a tool that can measure amps, volts, and ohms. It is used by technicians in most fields that involve electrical work including the computer industry because it can help diagnose electrical problems. In use, you connect the the DIMM so it becomes part of the circuit, and the digital display shows the selected measurement.

The total resistance of all resistors in a circuit depends on both their individual values and how they are connected. When resistors are in a series, or straight line, the current from the voltage source flows through them sequentially, or one after the other. So, the total resistance in the circuit is equal to the sum of the individual resistances. When resistors are placed parallel, with each resistor connected directly to the voltage source, each resistor gets the full voltage of the source. More current flows from the source, so the total resistance is lower. In fact, the total resistance in the circuit is equal to the sum of the inverse, or opposite, of each individual resistance.

Software Controls the System

Recall that the software that tells a computer how to do its work is the operating system, or OS. The OS does many different jobs:

- Working with peripherals: moving data and commands between the CPU and monitors, printers, and disk drives
- Managing data: finding the needed programs and files
- Using memory: storing data and programs in RAM or on the hard drive
- Coordinating data processing: doing many tasks at once without interfering with one another
- Providing the user interface: organizing and displaying the options you see on your screen when you turn on your computer

Systems Compatibility The two most popular operating systems are Microsoft® Windows® and the Macintosh OS®. Both use text and images to represent data and programs. The Macintosh OS runs on Apple® computers. Earlier versions of Mac OS ran only on computers with Motorola® processors. The latest versions of Mac OS run on computers with either Motorola or Intel® processors. Windows also runs on computers that have Intel processors or processors that are made to work like Intel chips.

For many years, the two systems were not compatible. That is, programs written for one OS did not run on the other. Also, files saved in one OS had formats that could not be read by the other OS. Today, some programs are written for both systems. Most files can be written, saved, and read in formats usable in both systems. Also, utility programs can translate files that previously may have been unreadable.

Figure 2.1.4 This is a Windows 8 Start Screen, which is the main starting place for working with Windows and programs.

Basic Programming Concepts

Lesson 2–2

Objectives

- Explain the binary system used by computers.
- Describe how software is written and translated.
- Explain why Boolean Algebra is used in computers.
- Explain the function of algorithms and how they are used in programming.
- Identify the three components of structured programming.

As You Read

Outline Information Use an outline as you read to help you organize information about how software makes computers work.

Software Provides Directions

How does a computer know what to do with data in digital form? Software gives it the instructions it needs. Experts called **programmers** write the instructions that become software. Programmers write these instructions, called **source code**, using a programming language.

Procedural or Object-Oriented Programming There are two basic categories of programming, procedural and object-oriented. **Procedural programming** uses step-by-step instructions to tell a computer what to do. Procedural programming languages include C, Fortran, Pascal, and Basic. **Object-oriented programming** provides rules for creating and managing **objects**, which are items that include both data and how to process the data. Object-oriented programming languages include Java, Alice, Python, and VBScript. Some programming combines the two. C++ is an example of a **programming language** that uses both procedural and object-oriented programming.

Compilers and Interpreters Special programs called **compilers** translate the source code into binary form, using only 0s and 1s. The result, called **object code**, can be read and acted on by a computer. Sometimes, programs called **interpreters** are used to translate the source code directly into actions, bypassing the need for a compiler. Interpreters are able to immediately follow the instructions in the binary code while compilers must first wait and translate the binary. Even though the compilers take longer to get started, they are able to complete task much faster than interpreters.

Representing Data Some programming languages require the programmer to assign a data type to variable data. Some common data types include string, which is a sequence of characters that does not contain numbers used for calculations; numeric, which is numbers or amounts that are used in calculations; character, which is text; integers, which represent whole numbers; and date, which is the method of coding dates.

Key Terms

- algorithm
- ASCII
- Boolean algebra
- character set
- compatibility
- compiler
- IF- statements
- interpreter
- logic gate
- object
- object code
- object-oriented programming
- operator
- procedural programming
- programmer
- programming language
- source code
- subroutine
- Unicode

Technology @ Home

By backing up your data, you make copies of data stored on your computer's hard drive to an external hard drive, USB flash drive, online storage service, or CDs/DVDs. Using an external hard drive with backup software or an online service lets you backup automatically. If you use CDs/DVDs or flash drives, you must back up data on your own.

Think About It!

Before deciding *how* to back up your hard drive, think about *why* it is important to back up. Sequence the importance of backing up each item in the list below using a scale of 1 (lowest) to 5 (highest):

- A program you can download from the Internet
- A report that you spent four hours on
- A file not used for a year
- Photos of friends
- Stored files of a game

Digital Computing

The computers widely used today are digital machines. Each piece of information used in the computer is identified by a distinct number. As a result, the computer acts on each piece of data by comparing its value to the value of other data or by performing a mathematical operation on it.

The Binary World Most computers are not just digital but binary, too. That is, they only recognize two possible values. Think of a television's power switch. It, too, is binary: The switch is either on or off. There are no other possibilities.

Computers break data into pieces called bits and give each bit a value of either 0 or 1. A byte is a group of bits—usually 8. Using 8 bits in different combinations, each byte can represent a different value. For example, one byte might be 00000000, another might be 01010101, and another might be 00110011. There are 256 possible combinations!

Data in Bytes Every piece of data that a computer works on, therefore, must be expressed in 0s and 1s and organized into bytes. These bytes can alone represent characters and numbers or be taken in combination to express more complex instructions like displaying color.

Digitizing Text Programmers use 0s and 1s arranged in 8-digit bytes to represent the letters of the alphabet and many standard punctuation marks. American Standard Code for Information Interchange (**ASCII**) is a common system, or **character set**, for coding letters that uses 8 bits. **Unicode**, which uses 16 bits, is another.

Spotlight on...

GRACE MURRAY HOPPER

"[Everyone will have quick access to information] in the next generation—when our bright youngsters take over. I watched third-grade students. . . write programs in BASIC and debug them. They'll be able to handle the computers when they grow up. . . ."

Grace Murray Hopper

Grace Hopper was a talented mathematician who joined the Naval Reserve during World War II. She worked on a computer the Navy was building, and she became the computer's first programmer. She also was a key figure in the development of compilers. Hopper's work helped make computers what they are today—tools that process text as easily as numbers.

Programming Creates the Software

The Language of Computers People communicate using words made up of 26 letters. Computers communicate using programs made up of two numbers—1s and 0s. No matter how complex, all computer tasks within a program are based on directions given in 1s and 0s.

To write computer code, programmers use math called **Boolean algebra**. Boolean algebra only has two values: true and false. This form of algebra is perfect for programming because binary also has two values. While using Boolean math in programming, 1 is true and 0 is false.

When you solve a math problem, you use an operation like addition or multiplication to find the relationship between two numbers. Boolean calculations are solved with the Boolean **operators** *AND*, *OR*, and *NOT*. These operators compare one or more Boolean values. When using the *AND* operator, if two values are true, then the solution is true; otherwise it is false. With the *OR* operator, if either of two values is true, then the solution is true. The *OR* operator is only false when both values are false. The *NOT* reverses a value from true to false.

Computers use physical devices consisting of a group of switches called a **logic gate** to preform Boolean equations. Using a combination of logic gates, programs direct the computer to perform more complex functions like computing advanced math or playing a song from an audio file.

Did You Know?

Boolean operators are used outside of algebra as well. When you use a search engine to search for information online you can use Boolean operators to fine-tune your search results.

- If you search for George Washington *AND* the American Revolution, the search engine would display links to Washington's efforts during the revolution.
- If you search for Washington *OR* the Revolution, the list includes links about Washington and links about the Revolution.
- If you search for Washington *AND NOT* the Revolution, the list includes links to Washington's life outside the American Revolution.

Solving Boolean Algebra with Truth Tables

AND		
X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

OR		
X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	1

Figure 2.2.1 Charts called Truth Tables can be used as a quick reference to find the solutions to Boolean algebra problems. The values in the equation are X and Y. The solution is Z. For example, with the AND truth table, when X and Y equal 0, or false, then Z equals false.

Did You Know?

Software is written in lines of code. Each line is an instruction or a comment. Operating-system software can take up a huge number of lines of code in different machines. Here are some comparisons:

- an ATM: 90,000 lines
- air traffic control: 800,000 lines
- Microsoft Office 2010: 10 million lines (estimated)
- all Internal Revenue Service programs: 100 million lines

Programs are Directions

Programs are a sequence of instructions that result in the computer performing a specific task. This sequence of instructions is called an **algorithm**. In a program, the algorithm is a designated sequence of calculations. The calculations are always done in the same order and steps are never skipped, so the result is always the same. Algorithms do not have to be a sequence of calculations. They can be a sequence of instructions that result in a predictable outcome, or solve a specific problem. When you bake a cake, the recipe is your algorithm. If you follow the recipe steps precisely and in the correct order, the result is a successful cake.

The Structure of a Program

There are three main components in programs: *sequence*, *decision*, and *loop*. Programs follow the same *sequence* of actions every time they run. If a program is solving the equation 2(x+1), it always adds 1 then multiplies by 2. If it performs the operations in a different order—say, multiplies by 2 and then adds 1—the answer would not be correct. The computer ends each action with a *decision*. The decision is the choice the program takes at the end of each step. The decisions are determined with **IF- statements**. An IF-statement defines conditions that must be met for the program to move to the next step. For example, *IF* you have finished adding the ingredients to the cake batter, *then* you can put the cake in the oven. Sometimes an action is repeated in a *loop* until a desired result occurs. When you are mixing the ingredients to make the batter, you stir until they are completely mixed. If the ingredients aren't mixed after one stir, you stir again, repeating the same action.

Some sequences are described in a single line of code called a **subroutine**. With a subroutine, a programmer can tell the computer to perform an entire sequence without having to type every step.

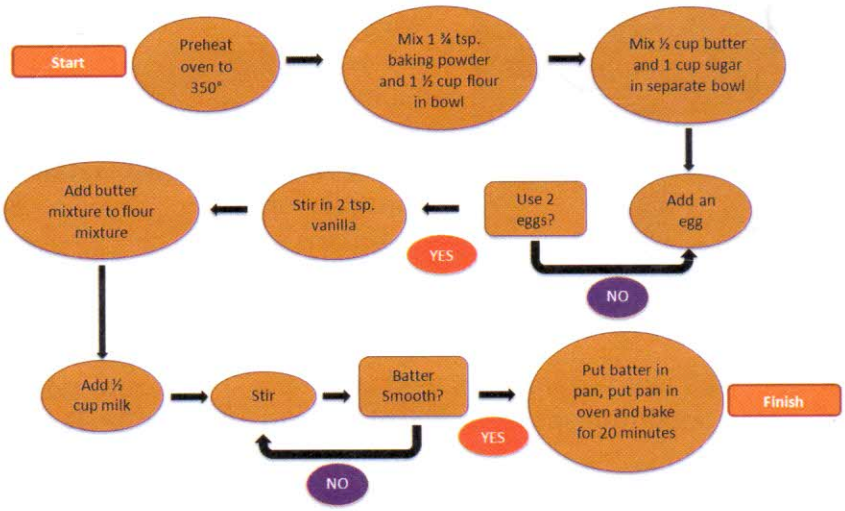


Figure 2.2.2
Algorithms can be illustrated using a flowchart, which has boxes connected with arrows, showing the order of steps. This flowchart shows the sequence of steps involved in following the steps in a cake recipe.

Group and Individual Computing

Lesson 2–3

Objectives

- Compare and contrast different kinds of computers used in organizations.
- Compare and contrast different kinds of computers used by individuals.

As You Read

Compare and Contrast Use a Venn diagram to help you compare and contrast information about the types of computers as you read the lesson.

A Dizzying Variety

Computers range in size from huge machines as big as a room to devices so small they can fit in your pocket. Each type of computer is suited to handling a particular set of jobs in particular settings. When thinking about this great variety of computers, it is helpful to look at them in two groups: those used by organizations and those used by individuals.

Key Terms

- desktop computer
- handheld computer
- mainframe
- server
- smart phone
- subnotebook computer
- supercomputer
- tablet computer
- wearable computer

Computers for Organizations

Companies and other organizations use the full range of computers. Large organizations can afford the largest and most expensive machines, and such companies are more likely to need all the processing power that these huge machines have. Many companies also want some of their workers, such as salespeople, to have small **handheld computers**.

Supercomputers The largest and most powerful computers can process huge amounts of data very quickly. These superfast scientific computers are called **supercomputers**. Where most CPUs can perform millions of calculations a second, supercomputers can perform millions upon millions of calculations a second. The organizations using supercomputers do very complex work, such as forecasting the weather or creating detailed models of nuclear reactions.

Supercomputers are not only the largest and most powerful type of computer, they are also the most expensive. A single supercomputer can cost hundreds of thousands of dollars or tens of millions of dollars. They are also extremely rugged and dependable systems, so users place constant heavy workloads on them.

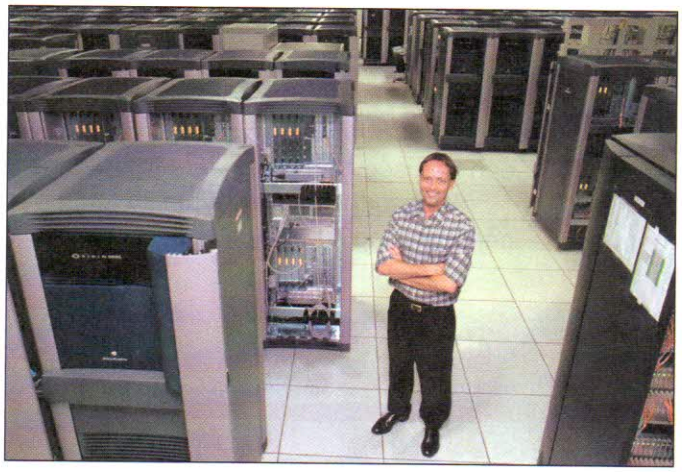


Figure 2.3.1 Some organizations use very large computer systems and house them in their own special environments.

Technology @ School

When computers are linked in a network, the network is set up to prevent people who have no right to be in the network from having access to the information. Typically, users use a password to gain access.

Think About It!

Think about the kind of information stored on a school network. Which informational items listed below do you think should have blocked access?

- class schedules
- students' grades
- students' health records
- sports team results
- scheduled school events

Mainframes The **mainframe** is another type of computer used by government agencies and large corporations. Mainframe computers are used in centralized computing systems as the storage location for all or most of the data. Other, less powerful computers connect to the mainframe so users can access the data. For example, airline company employees use mainframes to store and process reservations. In this way, reservations agents and travel agents all around the world can locate and use the same information at the same time. The trend now is to replace mainframes with servers. Even many government agencies have reduced the amount they rely on mainframes.

Servers Most organizations connect their computers together in a network. All the computers that are part of the network are connected to a computer called a **server**. The server holds data and programs that people on the network can use on their personal computers. A computer connected to a network, called the host, uses a special program called the client to contact the server and get data from it. Unlike terminals, computers on a network can have their own disk storage, but the main source of data for the network is still the server. Servers can be host- or client-based. If the server is host-based, the server runs the programs and receives directions from the client computers. In a client-bast server the programs and processing are split between the client and host computers. The networking found in servers can also be found in peer-to-peer networks, where computers in a system share resources and there is no host computer.

Real-World Tech

The Intelligent Room Some businesses are using a powerful new approach to working together called the Intelligent Room. The room looks like a normal conference room, but computer-controlled microphones and cameras placed around the room make sure that the speaker is always in view. This is especially helpful for video conferencing, in which a video of a meeting in one room is sent to another group of workers in another room. Screens mounted on the wall can be used to display data from computers simply by touching the screen.

Why is the camera's ability to follow the speaker useful for video conferencing?

Computers for Individuals

Most individuals do not need as much computing power as organizations do. They can use smaller—even mobile—devices for their computing needs.

Workstations The most powerful and expensive personal computers are workstations. Architects, engineers, designers, and others who work with complex data use these machines for their power and speed.

Personal Computers Most individuals use personal computers to do everyday jobs more quickly and easily. **Desktop computers** are personal computers that are small enough to fit on or under a desk but too large to move around easily. Desktop computers may be connected to a network or they may be standalone, which means they are not connected to any network.

Small portable computers such as laptops and notebooks are as powerful as a desktop but can be easily carried around. They usually include an internal hard drive. They can connect to an AC power source or run on battery power. Laptops usually have a monitor, keyboard, and pointing device built-in, as well as ports and Wi-Fi for connecting to peripherals and the Internet. Some, called all-in-ones, have touch screens, as well.

Tablet Computers Tablet computers are small, portable computers that have a flat panel display. The display is usually a touch screen, which can be used with a finger or a stylus. They may have ports and usually allow wireless connection to peripherals and a network. The primary characteristic of a tablet is its small size. Most are about 6-inches wide by 8-inches tall and weigh less than 1 pound.

Smart Phones A **smart phone** is a telephone with computing capabilities. Most smart phones are mobile, or cellular. Smart phones provide Internet access using 3G, 4G, or Wi-Fi technology. They run apps, which are small programs designed for one purpose, such as checking the weather, finding a nearby restaurant, or playing a game. Smart phones have built-in devices such as cameras, microphones, and speakers. They have internal storage for saving data such as pictures, music, contact information, and a calendar. Smart phones also have the capability to send and receive e-mails and text messages. Some smart phones have attached keyboards, but most use a pop-up keyboard on the touch screen display.

Computer Engineer Designing compact, powerful machines like subnotebooks and PDAs is the work of computer engineers. They design and test components and then put them together to make sure they work properly. Engineers need to know software and programming as well as understand the workings of hardware. Demand for computer engineers is expected to be good in the coming years.

Mobile Devices While all portable computers are mobile, including laptops, notebooks, and tablets, the term generally refers specifically to smart phones and handheld or **wearable computers**.

- A **personal digital assistant (PDA)** is a small, highly portable handheld computer that is used for taking notes or keeping track of appointments. Some similar devices include the ability to read barcodes and smart cards.
- Wearable computers are designed to be worn on the body, leaving the hands free for other tasks. They are usually intended for a specific purpose, such as inventory control or for monitoring body systems, such as heartrate. They may be worn on the arm or wrist or around the waist like a belt. Smartwatches are worn on the wrist and tell the time along with having the ability to run apps. Some wearable computers are worn as eyewear and can affect vision or display information.

Figure 2.3.2 Smart phones and tablets are small, light, and powerful.

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

b 1. command
c 2. motherboard
g 3. read-only memory
i 4. programmer
h 5. compiler
e 6. supercomputer
a 7. algorithm
j 8. server
f 9. desktop computer
d 10. circuit

a. a sequence of instructions
b. instruction for the computer to do something
c. a network of connected electronic components
d. where the CPU is located
e. high-speed computer for complex work
f. another name for personal computer
g. set of chips that starts the computer when it is turned on
h. language that translates source code into binary form
i. writes instructions for a computer to follow
j. computer accessed by users on a network

Check Your Comprehension

Directions: *Determine the correct choice for each of the following.*

1. What would you most likely use a microphone to input?
   a. commands
   b. images
   c. sound
   d. text
2. Data from which part of a computer is lost when it is turned off?
   a. the CD-ROM
   b. the hard drive
   c. RAM
   d. ROM
3. Which is NOT a component in programs?
   a. loop
   b. choice
   c. sequence
   d. decision
4. Which is an example of a binary number?
   a. 10011001
   b. –342
   c. 67439622
   d. .0000002
5. Which of the following is NOT a task performed by operating systems?
   a. controlling a printer
   b. managing memory
   c. coordinating how programs run
   d. compiling a program
6. What kind of machine is more powerful than a server?
   a. desktop computer
   b. portable computer
   c. mainframe
   d. handheld computer

Think Critically

Directions: *Answer the following questions.*

1. What are the functions of compilers and interpreters?

2. Explain the difference between the operation of compilers and interpreters.

3. Identify and explain the concept of an algorithm.

4. Explain how the following data types are used to represent variable data in software development: string, numeric, character, integer, and date.

5. List at least three object-oriented programming languages and three procedural programming languages. Explain how they are used in software development.

Extend Your Knowledge

Directions: *Choose and complete one of the following projects.*

A. Make a flowchart for a sequence of actions you do every day, such as getting ready for school or packing your lunch. Does your flowchart contain the main components of programs: sequence, decision, and loop? Create an IF-statement for one step of your flowchart.

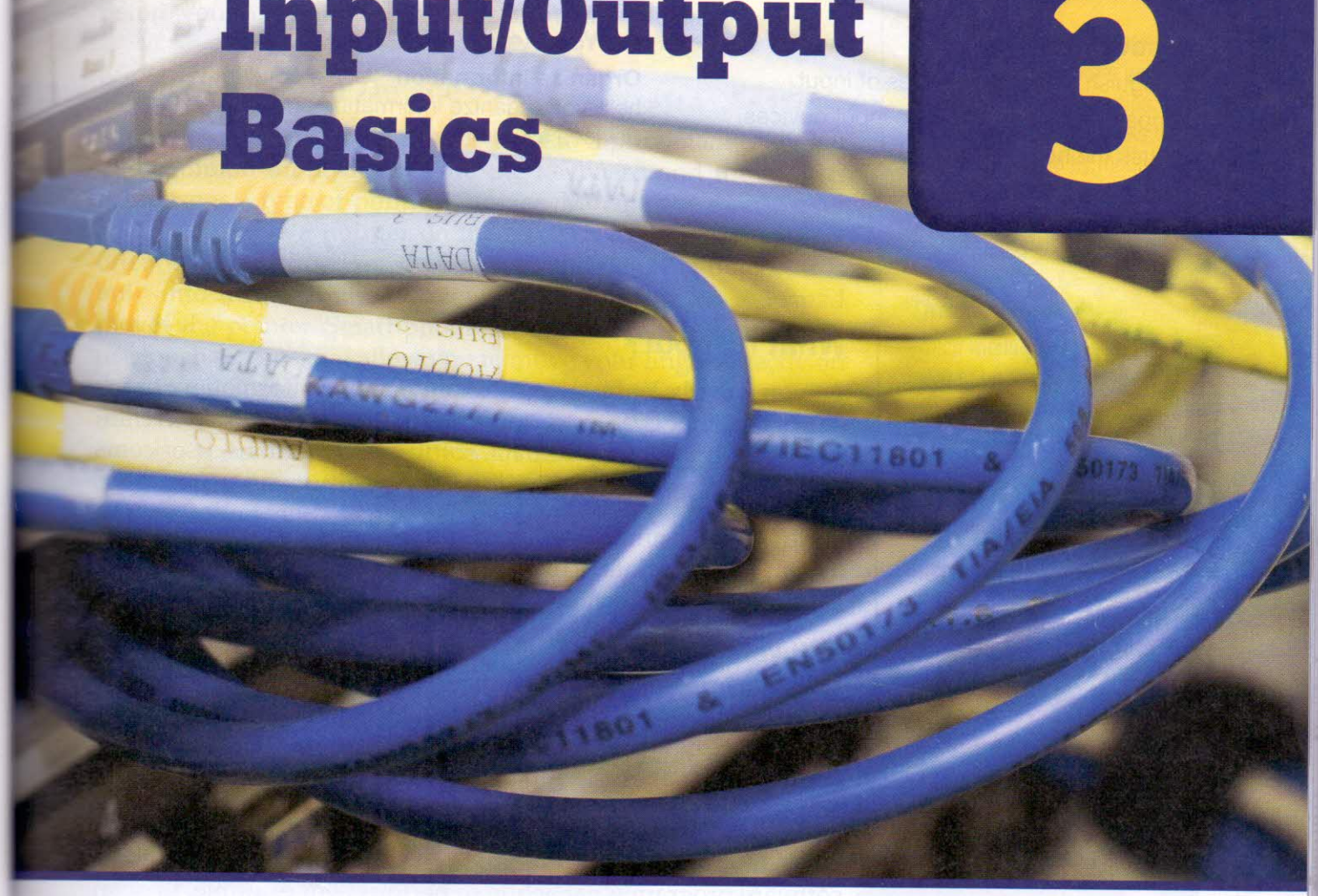
B. Collect three advertisements for home computer systems. List the components that are offered in each ad. Compare the three systems for their appropriateness for inputting and outputting text, images, and sounds. Compare their capacity to store data. Based on the features, write a brief explanation of which machine you think is best and why. Read your explanation out loud to a partner and listen as your partner reads his or hers out loud to you.

C. Work with a partner to practice using a digital multimeter (DIMM). Being sure to follow all safety protocols, use the DIMM to measure AC and DC voltages. Then, measure AC and DC current. Finally, measure the resistance of a circuit consisting of resistors. If possible, construct simple circuits on a breadboard or with a soldering iron.

chapter

3

Input/Output Basics



Input and Output If you think of the computer as a person, its brain would be the central processing unit, or CPU. Like a brain, a CPU receives and organizes data from many different sources into useful information.

Also, like a person, a computer needs more than just a brain to work properly. It needs a way to receive the unorganized data and to show the results of its processing of the data. The brain receives data through the senses: sight, hearing, smell, taste, and touch. It shows the results of its processing of the data through speech, movement, and writing. The CPU receives its data from input devices such as the keyboard and mouse. It shows the results of its processing through output devices such as a monitor, printer, or speakers.

Chapter Outline

Lesson 3–1

Basic Input Devices

Lesson 3–2

Basic Output Devices

Lesson 3–1 Basic Input Devices

Objectives

- Distinguish among four types of input.
- Compare and contrast basic input devices.
- Discuss the health risks of using some input devices.

As You Read

Organize Information Use a concept web to help you organize information about basic input devices as you read.

Key Terms

- command
- digital camera
- ergonomic
- pointer
- pointing device
- repetitive strain injury (RSI)
- scanner
- webcam

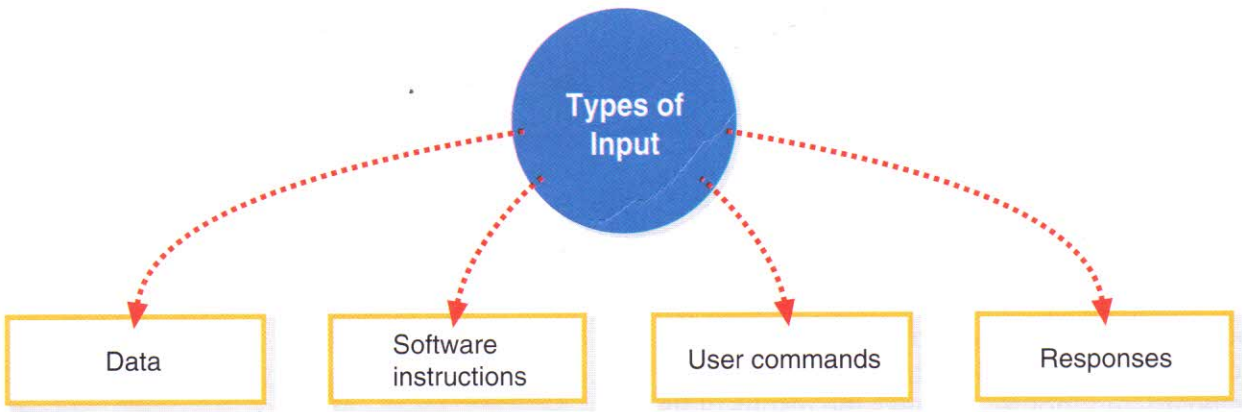
What Is Input?

As you already learned, input is any kind of information, or instructions, that is entered into a computer's memory. There are four basic types of input: data, software instructions, user commands, and responses.

Data Words, numbers, images, and sounds that you enter into a computer are data. This is the raw material that a computer processes.

Software Instructions To perform any job, a computer must follow instructions from a software program. Software typically is installed from a CD or downloaded from the Internet onto the hard drive. Launching a program moves it into the computer's RAM. That makes the program available to the CPU—and to you.

User Commands A **command** is an instruction that tells a software program what action to perform. For example, to open a program, save your work, or close a program, you must issue a command to the computer.



Responses Sometimes a program asks you to enter information or make a choice so that it can carry out a command or process data. For example, if you try to close a program without saving your work, the program will ask if you wish to save it. Before you can continue, you must input a response.

What Is an Input Device?

An input device is any hardware used to input data. Recall that two common input devices are the keyboard and the mouse. A mouse is a type of **pointing device**. Moving the mouse over a surface moves a **pointer** on the screen. Notebook computers often use a touchpad, or trackpad, as the pointing device. It is built into the computer. Moving your finger on the touchpad moves the pointer. Smart phones, some computers, and tablets use touch screens that allow you to move your finger directly on the screen. Some can sense motion and react to a hand moving in front of the screen or even respond to eye movements. There are also specialized input devices, such as digital cameras, for capturing and inputting photos and videos, microphones for inputting sound, and even global positioning systems (GPS) used to input maps and locations.

Game Controllers Game controllers are handheld devices that let you input command and interact with video and computer games. They usually have buttons, directional pads, and even motion sensors. A joystick is a lever that can be moved in all directions to move objects on the screen. It may be used with computer games, flight simulators, or virtual reality programs.

Technology @ Work

Some people have disabilities that prevent them from working a mouse with their fingertips. Two companies make joysticks that can be controlled by mouth. Moving the stick up and down or from side to side moves the cursor on the screen.

Think About It!

Which mouse actions do you think need to be considered in an adaptive input device for people with physical disabilities?

- select text
- scroll through a document
- create art in a drawing program
- click the mouse button to select a menu option
- cut text

Spotlight on...

DOUG ENGELBART

"We were looking for the best—the most efficient—device. We . . . said 'let's test them,' and determine the answer once-and-for-all. . . . It quickly became clear that the mouse outperformed all the [other devices]."

Doug Engelbart

In the 1960s, Doug Engelbart created the mouse—a device that could be used to move a cursor around a computer screen.

The first mouse was a crude wooden box with two round discs on the bottom and a button on the top. The long cord that connected it to a computer looked like a tail.

A visionary, Engelbart also thought computers could be used as writing machines, or word processors.

Microphone To input sounds, you can use a microphone or a sound card (inside the computer) to record and play back sounds. Many computers, including smart phones and tablets, use sound input for direction. Voice recognition programs, like Apple's Siri or Google's "OK Google," are used to start searches on smart phones.

Digital Cameras, Webcams, and Scanners **Digital cameras** connect to the computer by a cable or a wireless link to input photos. When you video chat with a friend you're using a **webcam**, a small camera that either attaches to the computer monitor, sits on your desk, or—like Apple's iSight—is built into the computer. Webcams usually come with software that enables you to record video or stream the video on the Web. **Scanners** are devices that let you copy printed images into a computer and can be stand-alone or part of your printer. The scanner changes the printed image into a digital form.

Modem and Routers Modems and routers direct the input of data between multiple computers. A modem converts data from one form to another. Originally modems were used send computer data over telephone lines so computers could access the Internet through dial-up. Modern modems can send information through cable, satellite, or DSL. Routers forward data from one source to another, such as between two computers or between a computer and the Internet. For Internet access, a router is connected to a modem. The modem connects to an Internet provider and the router directs the flow of data between the Internet and computers.

Health Risks of Some Input Devices

When you use a keyboard or mouse a lot, you make the same hand movements over and over again. This can cause damage to nerves in the hand. The problem is called **repetitive strain injury**, or **RSI**. **Ergonomic** keyboards have been designed to reduce RSI. Some people who suffer from this problem use a mouse controlled by foot pedals or some other kind of pointing device. Proper posture and lighting and limiting the amount of time you spend looking at a screen can help prevent health problems.

Figure 3.1.1 Specially designed keyboards, like this one, can reduce the risk of repetitive strain injuries.

Did You Know?

You might think that repetitive strain injury only affects adults who work all day at a computer. Researchers are trying to find out if children can also be affected by repeated use of the keyboard and mouse. They have learned that children run some risk of injury.

One thing that can reduce this risk is to have the keyboard and mouse positioned lower than the computer. Many students, though, prefer to have these devices on top of a table. They want to be able to see the keys as they type!

Basic Output Devices

Lesson 3–2

Objectives

- Distinguish among the four types of output.
- Compare and contrast basic output devices.
- Explain how visual display systems work.
- Summarize printing technology.

As You Read

Outline Information Use an outline format to help you organize information about output as you read.

What Is Output?

After a computer has processed data, it provides the results in the form of output. There are four types of output: text, graphics, video, and audio.

Text Characters such as letters, symbols, and numbers are called text. To be considered text, the characters must be organized in a coherent way. For example, random letters on a page are not considered text, but paragraphs in a book report are text.

Graphics Drawings, photographs, and other visual images are called graphics.

Video Moving images are known as video. Images captured by a digital video camera, and which can be played on a computer, are one example of video. The use of animation is another example.

Audio Sound output is called audio. This includes music or speech that the computer plays through its speakers or headphones.

Key Terms

- All-in-One printer
- cathode ray tube (CRT)
- impact printer
- liquid crystal display (LCD)
- nonimpact printer
- output device

Figure 3.2.1 This is an LCD monitor—an output device for displaying text and graphics.

Technology @ School

Some schools have a special kind of monitor that is an educational tool. The SMART Board™ allows teachers and students to project text and images onto a special monitor mounted on the wall. Not only is the image visible to all students, but it can also be manipulated and changed, making learning more interactive.

Think About It!

Think about ways the SMART Board can be used at school. For which examples below do you think the SMART Board would be useful?

- solve math problems
- play music
- edit text
- display reports
- meet in groups

What Is an Output Device?

An **output device** is any piece of hardware that displays or plays back the result of computer processing in one of the four forms of output. For example, monitors and printers create a visual record of the processing completed by the computer.

Monitors

The computer displays information on a monitor, a hardware device that receives and shows images on a screen. The images the monitor displays change as the computer processes data.

LCDs Modern monitors use the **liquid crystal display**, or **LCD**. In an LCD, two transparent surfaces are placed on either side of a layer of cells containing tiny crystals. Electrical signals sent to the crystals cause them to form images on the surface.

LCDs are very light and have a flat screen. They use little power and can even be operated using just batteries. Also, there are now two different techniques for producing color: thin film transistor (TFT) and passive matrix technology. TFT produces sharper color and images, so it is becoming the standard.

CRTs An older type of monitor is the **cathode ray tube**, or CRT. In a CRT, the monitor receives electrical signals from the computer. The signals cause "guns" in the CRT to shoot a stream of electrons at the back of the screen. The electrons strike materials called phosphors, which begin to glow. The glowing phosphors appear as points of light on the screen.

Touch Screen Monitors Touch screen monitors, used on smart phones, tablets, and some computers, are designed to respond to input from a finger or stylus touching the screen. There are pros and cons of using a touch screen with the most important being personal preference. The trend is moving toward touch screens, as many people find swiping with a finger easier, faster, and more intuitive than using a keyboard, mouse, or touch pad.

Figure 3.2.2 Touch screens are used for tablets, smart phones, and some notebook PCs.

Currently, there are two main types of touch screens:

- Analog resistive touch screens are made of two layers: usually one is glass and the other is plastic film. They are each covered with a grid of electrical conductors. When you touch the screen, there is contact between the grid on the glass and the grid on the film, creating a circuit. The monitor detects and responds to the change in electric current resistance at the spot of the touch.
- Projected capacitance (pro-cap) touch screens also use two layers of conductors, but they rely on electrical capacitance, which is the build-up of electrons in an object. When you touch the top layer of the screen, the screen takes some electrons—or charge—from the other layer. The monitor responds to the change in the charge.

Color monitors have three electron guns, each one shooting a beam of a different color: red, blue, or green. CRTs today are now capable of producing thousands of colors. Some of the first monitors and televisions were CRTs. However, these monitors are not only heavy and take up a lot of desk space, but they also heat up easily. CRTs use more electricity than LCDs. As LCDs became more affordable, companies stopped producing and selling CRTs in the United States.

Printers

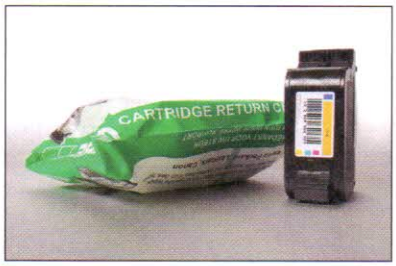
A printer makes a paper copy of the display shown on a monitor. The most common types of printers are nonimpact printers, which have made impact printers almost obsolete.

Career Corner

Test Engineer Before equipment is manufactured and sold, it needs to be designed. New models, called prototypes, have to be tested.

The work of test engineers is to make sure that the equipment works the way it is supposed to. If it does not, the test engineer has to explain to the design team what went wrong.

Real-World Tech



e-cycling You've probably noticed that your printer ink cartridges can be recycled at your local office supply stores. However, did you realize that you can recycle your old computer or other electronic equipment that still works? The best way to do this is to donate them to schools, other nonprofits, or low-income families in need. To help you do this—and keep our country greener—the Environmental Protection Agency has a Web site that lets you find local programs, manufacturer-retailer programs, and government supported donation and recycling programs:

http://www.epa.gov/osw/conserve/materials/ecycling/donate.htm

Nonimpact Printers Most computer users today use these inkjet and laser printers to produce paper copies. Inkjet printers make images by spraying a fine stream of ink onto the paper. Laser printers use a powder called toner and operate like a copier machine. Heat fuses the toner to the paper to create the image. Laser printers create more crisp images than inkjet. Both inkjet and laser printers are available in **All-in-One** versions that add fax, copier, and scanner capabilities at a very low cost.

Impact Printers Dot matrix printers are a kind of impact printer that uses hammers or pins to press an ink-covered ribbon. They are noisy and the image quality is poor, but some are still used in businesses to provide copies of multi-part forms, like invoices.

Real-World Tech

Three-Dimensional Printers

Three-dimensional objects can be modeled in software and then created by computers using a three-dimensional (3D) printer. 3D printers build objects by slicing the digital model into thin layers and then printing the layers as sheets. These sheets are then joined together to produce the three-dimensional object. Many 3D printers build objects with plastic or metal. 3D printers are used for product design in many industries ranging from footwear to medical devices.

If you had a 3D printer, what would you print?

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

j 1. command
f 2. pointer
b 3. output device
d 4. digital camera
h 5. scanner
i 6. repetitive strain injury
e 7. All-in-One printer
a 8. liquid crystal display
c 9. impact printer
g 10. nonimpact printer

a. produces images by sending electrical signals to crystals
b. any piece of hardware that displays or plays back the result of computer processing
c. device with hammers or pins that strike a ribbon to leave ink on paper
d. lets you input printed images into a computer
e. a printer that contains fax, copier, and scanner capabilities
f. follows a mouse's movements
g. device such as an inkjet or laser printer
h. takes photographs that a computer can read
i. condition caused by making the same movements again and again
j. instruction to a software program to take an action

Check Your Comprehension

Directions: *Determine the correct choice for each of the following.*

1. Which type of input provides answers to questions issued by programs?
   a. commands
   b. data
   c. responses
   d. software
2. Which device can be used to connect a computer to the Internet?
   a. keyboard
   b. modem
   c. pointing device
   d. scanner
3. Which of the following devices can be designed to reduce the problem of RSIs?
   a. scanner
   b. digital camera
   c. monitor
   d. keyboard
4. What do output devices provide?
   a. data to be processed
   b. software code
   c. text and images only
   d. results of processing
5. Which of the following is NOT descriptive of a CRT?
   a. heavy
   b. uses little power
   c. heats up easily
   d. affordable
6. What kind of output device would NOT be used to output images?
   a. CRT
   b. LCD
   c. printer
   d. speaker

Think Critically

Directions: *Answer the following questions.*

1. Why are microphones or digital cameras unlikely to cause the damage that is found in repetitive strain injury?

2. Identify the type and purpose of at least three specialized input devices.

3. What type(s) of monitor(s) do you use at school? What are the advantages and disadvantages of the different types of monitors?

4. How is video similar to ordinary graphics? How is it different?

5. Why have nonimpact printers all but replaced impact printers?

Extend Your Knowledge

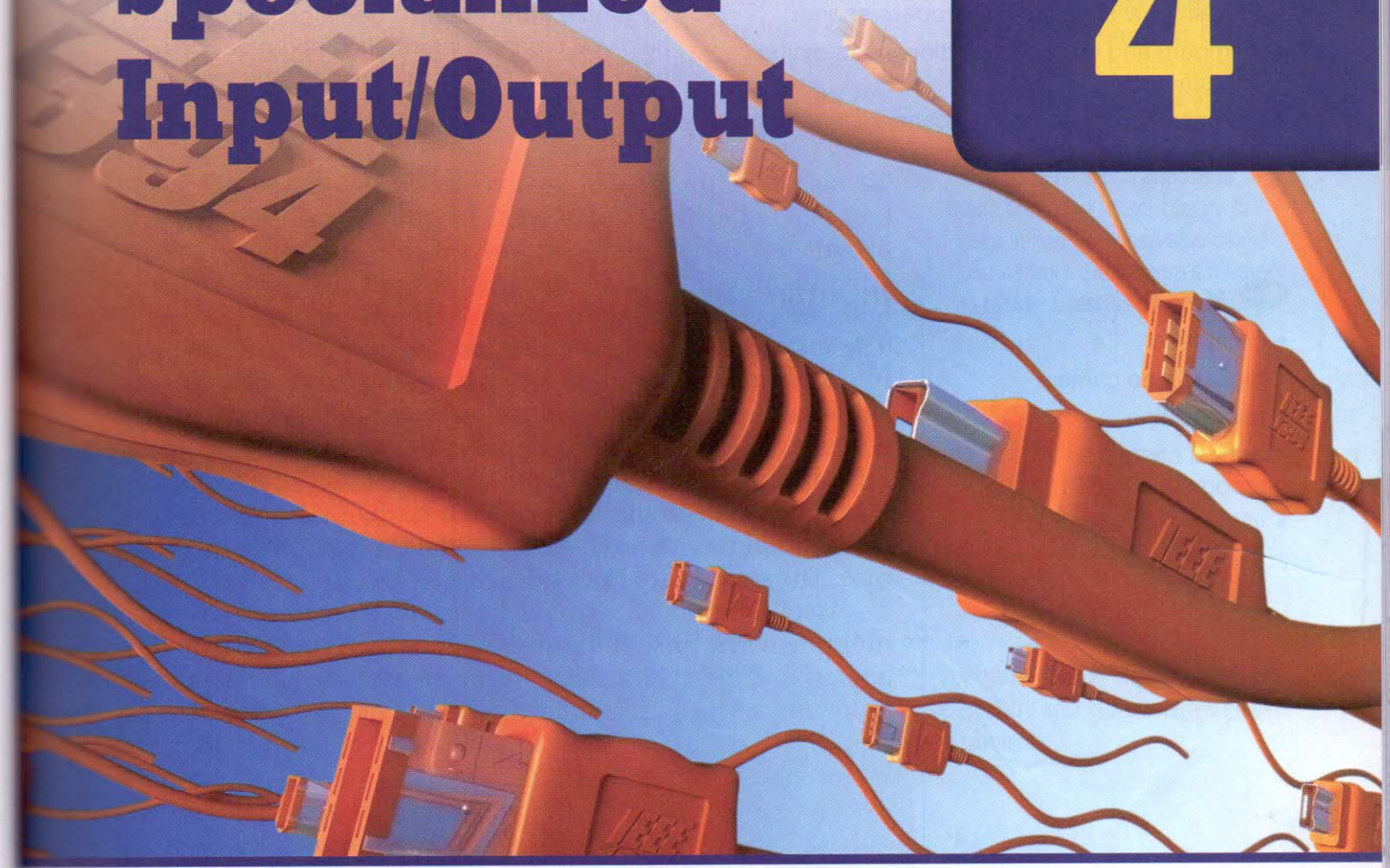
Directions: *Choose and complete one of the following projects.*

A. Open a word-processing program. Use the keyboard to input the definition of the word "Text" on page 33. Input the paragraph a total of five times. Each time you do so, time yourself. Print the five paragraphs. Compare the five times. Determine whether you were able to type faster and more accurately with practice.

B. With your teacher's permission, practice disconnecting and connecting your computer system's input and output devices. For example, disconnect and connect the mouse, keyboard, and printer. Then, verify that the devices are working correctly by opening a word-processing document and typing a paragraph about the different input and output devices you are working with. Move around in the document using the keyboard and the mouse, and edit the paragraph to include an explanation of which device you think is easier to work with and why. With your teacher's permission, print the document. Read your paragraph to a partner or to the class and answer any questions.

Understanding Specialized Input/Output

chapter 4



From Text to Moving Pictures Modern personal computers work in basically the same way that early personal computers did. Both perform the same four operations: input, processing, storage, and output. Both turn different sources of data into useful information. There is a major difference between what earlier and more recent computers can do, however.

Early personal computers could work with text and numbers. Today's computers can also handle different types of data, such as still images, sound, and video. Hardware makers have designed new devices to allow users to input data and output information in new ways. These devices have taken computers from the still and silent world of text and numbers into a dazzling multimedia world of sound, images, and motion.

Chapter Outline

Lesson 4–1
Specialized Input Devices

Lesson 4–2
Specialized Output Devices

Lesson 4–1 Specialized Input Devices

Objectives

- Explain how sound cards process sound.
- Compare and contrast traditional and digital cameras.
- Compare digital cameras, scanners, and digital video cameras.

As You Read

Organize Information Use a concept web to help you organize information about devices used to input sound, still images, and video as you read.

Key Terms

- compress
- digital video camera
- fax machine
- optical character recognition (OCR)
- video capture card

Inputting Sound

The microphone is the most basic device for inputting sound into a computer. You use it for all types of sound, including music, narration, and speech for voice recognition software. Microphones capture sounds in analog form—as a series of rapidly changing waves or vibrations. To be usable by a computer, sounds must be in digital form, that is, the waves must be converted to binary code (1s and 0s) that the computer can recognize. The sound card does this work.

A sound card is a circuit board that processes sounds in multiple ways. First, it digitizes sounds by changing them from analog to digital form. Then, it processes the digital sounds by following a set of built-in instructions. For example, it can prepare the digital sound files for use with voice recognition software. Sometimes the sound card reduces the size of sound files by compressing the data. That way, the files take up less space in memory. Finally, the sound card reverses the digitizing process so you can play analog sounds through the computer's speakers.

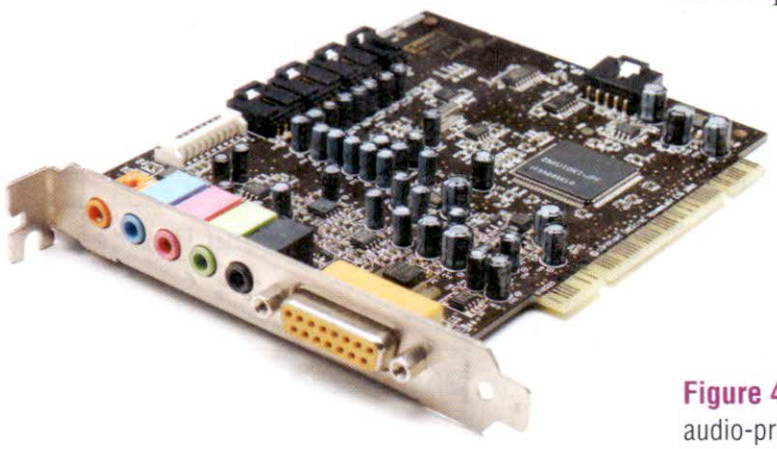


Figure 4.1.1 A sound card handles the audio-processing tasks in a computer.

Inputting Still Images

There are several different ways to input still images into a computer. They include facsimile (fax) machines, digital cameras, and scanners.

Facsimile Machines A **fax machine**, or facsimile machine, scans printed documents and sends them over phone lines to another fax machine. Though fax machines are still used by some companies, many documents that were once sent as a fax are now sent online as image files.

Digital Cameras A digital camera, like a traditional camera, takes pictures. In a traditional camera, light enters the lens and strikes a piece of film coated with chemicals that are sensitive to light. The chemicals produce an image on the film. In a digital camera, a computer chip takes the information from the lens and records it as pixels, or small dots, that form the image. A digital camera has memory to store the pictures you take.

Some digital cameras store images on a memory card that can be removed. If a computer has the correct device, it can read the images from the memory card. Many digital cameras, including smart phones, can connect to a computer via a cable or wireless link. When the camera is connected, the computer treats it like a disk drive and the pictures can be copied to the computer.

Connections

The Arts A digital camera can take pictures that use from 4 to 20 million dots (pixels) to make the picture. The more dots it uses, the sharper the image is. But more dots also take up more space on the memory card where the pictures are stored in the camera.

Photographers can choose to take photos of lesser quality to save space. They can also delete photos from the camera's memory to make space for new ones.

Figure 4.1.2 Digital cameras capture and store images electronically.

Technology @ Work

Scientists use an input device called a sensor to record many different kinds of data. Sensors can detect physical phenomenon, such as humidity, air pressure, and temperature.

Think About It!

For which examples below could a sensor be used?

- weather forecasts
- climate control
- monitor of medical patients
- work by robots

Scanners Any printed document can be digitized by using a scanner. Scanners shine a light onto the material to be copied and change the image into pixels. This creates a digital image that can be input.

Most scanners have **optical character recognition**, or **OCR**, software. When you scan printed text using this software, the text is turned into a digital file. In this way, you can input printed text, including handwriting, without having to type it.

There are different types of scanners:

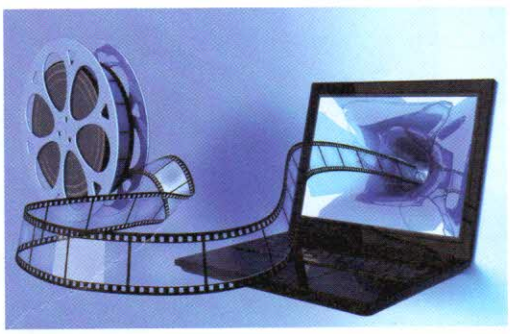
- With a sheetfed scanner, you insert the pages you want copied and the scanner pulls them through one at a time.
- Flatbed scanners work more like copy machines. You lay material on a flat glass panel to make the copy. All-in-one printers have flatbed scanner capability.
- Handheld scanners are portable models that you hold in your hand. They are useful for copying small originals.

Inputting Video

You can input and display full-motion video and animation on a computer. Like all other forms of input, the videos must be in digital form. **Digital video cameras** record moving images in digital form. Most smart phones can record video, too.

To convert analog videos to digital format, a computer needs a **video capture card**. Like a sound card, this type of circuit board changes video images into a digital file. These cards also **compress** files so they occupy less disk space.

Real-World Tech



Crossing the Line There is another use for video capture that is strictly illegal. Some computer users digitize movies, pay-per-view events, and television shows and post them on Web sites. People can visit the sites, download the shows, and watch them for free. This breaks copyright law, which protects the rights of people who create works of art, such as books, songs, and movies.

Why would the government pass laws to protect the rights of authors, songwriters, and movie directors regarding the sale of their works?

Specialized Output Devices

Lesson 4–2

Objectives

- Distinguish among different video adapters.
- Compare and contrast different printers.
- Compare and contrast other output devices.
- Identify kinds of audio output.

As You Read

Gather Information Use a chart to help you gather information about output and output devices used for still images, video, and sound as you read.

Video Adapters

The images you see on your monitor are created by a **video adapter**. The adapter is a circuit board that receives data from an operating system or software application. It changes that data into electrical currents and sends them to the monitor. In a color monitor, the amount of current sent by the video adapter determines the color the monitor will produce. Like a sound card, a video adapter processes data so that the computer's CPU can take care of other jobs. It also has its own memory, called **video memory**, or **VRAM**, to free up space in the computer's memory.

Special Video Adapters Some video adapters send images to the monitor very quickly. They are called video accelerators.

Key Terms

- data projector
- high-definition television (HDTV)
- Musical Instrument Digital Interface (MIDI)
- OLED
- speech synthesis software
- thermal transfer printer
- video adapter
- video memory (VRAM)

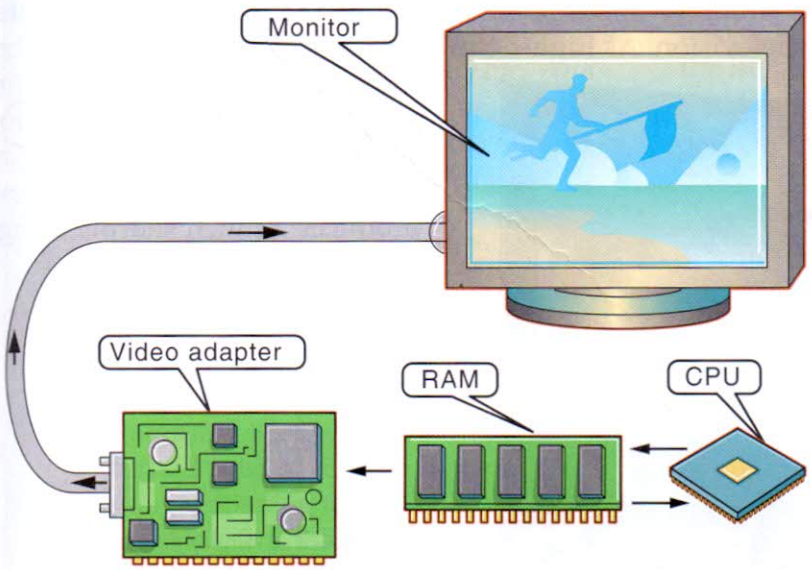


Figure 4.2.1 The video adapter processes video data for display on the monitor, allowing the CPU and RAM to handle other tasks.

Technology @ Home

Another new technology might help users of small video screens to see better in sunlight. **OLED**, or Organic Light Emitting Diode, technology consumes less power and produces better displays than current LCD screens. OLED screens also have very good video quality—the manufacturers call it "full motion" video.

Think About It!

Think of the small display screens that you have seen in use. Think also of the lighting conditions in which they are used. Which of the following products do you think could best use OLED display?

- Cell phone
- PDA
- Netbook computer
- MP3 player, like the iPod

Most computers today have highly specialized video adapters, called 3-D video adapters. Images on a monitor have only two dimensions—height and width. 3-D video adapters add a third dimension to an image—depth.

Outputting Images with Printers

Recall that image quality varies based on which type of printer is used to output an image. Both impact and nonimpact printers create images by printing tiny dots on the paper. Inkjet and laser printers have much higher print quality. Therefore, they are more often used for printing graphic images.

The best printer for printing color images is a **thermal transfer printer**. These printers use heat to transfer color dyes or inks onto paper. Thermal transfer printers do not make pictures out of tiny dots. Instead, the colors actually blend together on the paper. These printers only work with glossy paper.

Outputting Video

You can use three types of devices to output video.

Data Projectors You may be familiar with **data projectors**, which show a computer's video output on a projection screen so many people can view it at once. These projectors are often used to display presentations for educational or business meetings.

Digital light processing, or DLP, projectors use millions of tiny mirrors to create a very sharp image. That image is then projected through a lens and onto a screen. Because the image they produce is so sharp, DLP projectors can be used with large audiences. They can even be used in brightly lit rooms.

Televisions Some devices let you send video from a computer to a television. As **high-definition television**, or **HDTV**, has become more widely used, more people are using their television as an output device. HDTV uses only digital audio and video and produces a much sharper image than regular television.

Figure 4.2.2 Digital television systems produce much higher quality output than standard televisions.

Headsets A headset, which has two LCD panels, is worn over the head. The computer sends video images to each panel. To the person wearing the headset, it seems as if he or she is walking in a three-dimensional space.

A similar but larger device is the Cave Automated Virtual Environment, or CAVE. This is a room in which three-dimensional images are shown on the floor, walls, and ceiling. A person in the room wears 3-D glasses. The glasses and images create the illusion of interacting in three-dimensions.

Outputting Sound

To output sound to headphones or speakers, your computer must have a sound card and speakers. The sound card changes digital sound files stored in the computer's memory into an electrical current. It sends that current to the speakers to produce audio output.

The sound a computer can produce depends on the computer's software. Two kinds of software allow audio output:

- **Speech synthesis software** allows the computer to read text files aloud.
- **Musical Instrument Digital Interface (MIDI)** software allows the computer to create music. With this software, you can send instructions to a digital musical instrument called a synthesizer. This device then sounds the notes it has been instructed to play.

Did You Know?

One new technology goes beyond headsets and CAVEs to combine computers and people. Army researchers are trying to develop a special suit. Run by computers and guided by the wearer, the suit will include simple machines such as pistons. If it works, the suit will greatly increase the speed and strength of the person wearing it. Having powerful arms, for example, could be helpful during rescue operations.

Spotlight on...

RAYMOND KURZWEIL

"The Kurzweil Reading Machine was a breakthrough that changed my life. With the Kurzweil Reading Machine, I could read anything I wanted with complete privacy . . . . It gave blind people the one thing that everyone treasures, which is independence."

Stevie Wonder
Singer and songwriter

Raymond Kurzweil's reading machine turned printed text into spoken language, opening a world of information to people with visual impairments.

Kurzweil also devised the first electronic musical instrument. After Kurzweil spoke with singer and songwriter Stevie Wonder, he had the idea of making a better music synthesizer. Kurzweil's synthesizer could make the music of an entire orchestra.

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

f 1. compress
j 2. fax machine
d 3. optical character recognition
g 4. digital video camera
i 5. video capture card
h 6. video adapter
e 7. VRAM
b 8. thermal transfer printer
a 9. speech synthesis software
c 10. MIDI

a. turns text into audio
b. prints high-quality output suitable for photos
c. software that lets the computer play like an electronic instrument
d. software that scans text and turns it into a digital file
e. memory on a video adapter
f. to make files smaller
g. captures still images, which are then shown rapidly
h. controls video output to the monitor
i. converts analog video into digital
j. scans documents and sends them over phone lines

Check Your Comprehension

Directions: *Complete each sentence with information from the chapter.*

1. To play sound that has been stored in a computer, it must be converted to Digital format.
2. Digital photos can be input from a camera by transporting them on a disk or sending them to the computer using a(n) video adapter.
3. OCR software allows people to scan text instead of rekeying it.
4. Photos that haven't been taken with a digital camera can still be input into a computer using either a fax machine or a(n) thermal transfer printer
5. The amount of current that a video adapter sends to the monitor determines the color display on the monitor.
6. Three-dimensional graphics include height, width, and depth.
7. DLP projectors are better than LCD projectors for giving a presentation to many people because the Images appear sharper.
8. Standard printers create output by printing tiny Dots on paper.
9. Headsets and the room-sized Images create virtual three-dimensional environments.
10. Audio can be output to headphones or speakers.

Think Critically

Directions: *Answer the following questions.*

1. What is one advantage of having memory on a video card dedicated to displaying graphics?

2. Why are sound and graphics files compressed?

3. Suppose someone had to scan ten images. Which kind of scanner would require him or her to stay closer to the machine as it is working, a sheetfed or flatbed? Why?

4. Would a 3-D graphics adapter be needed on a machine used mostly for word processing and spreadsheets? Why or why not?

5. Which kind of printer would be better for printing a report for school that included two or three photographs, an inkjet or a thermal transfer printer? Why?

Extend Your Knowledge

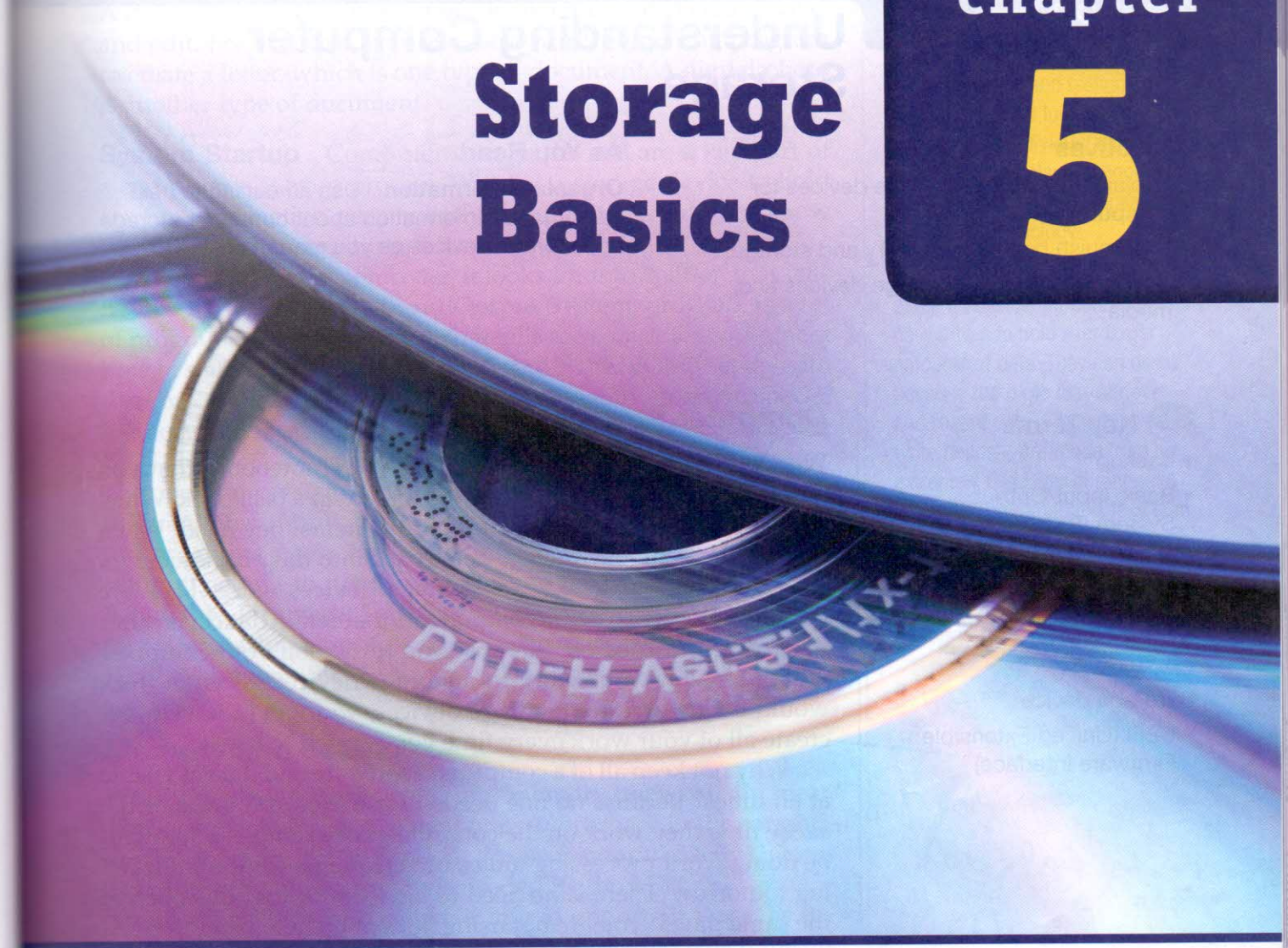
Directions: *Choose and complete one of the following projects.*

A. Divide a sheet of paper into two columns, creating a T-chart. Write the heading *Standard System* over the left column. Write the heading *Graphics System* over the right column. In each column, list the input and output components you would include if you were setting up these two computer systems. Include the types of output cards you would want. Assume that the standard system will be used for word processing and spreadsheet work. Assume that the graphics system will be used for high-quality photographs.

B. Find out what kind of sound your computer can output. If possible, output audio and then determine what kinds of software your computer used to output the sound. With a partner or as a class, discuss for whom audio output is an advantage and when this feature is a necessity.

chapter 5

Storage Basics



How Do Computers Store Data?

Computer storage is like the backpack you bring to school. Both store things until you are ready to use them. Your backpack stores books and school supplies; most computers store software and data.

Computer storage devices can store information for long periods of time. This lets you create a file today, save it, and then use it again in the future. In this chapter, you will learn why storage is necessary and how information is stored. You will also examine some of the storage devices you are likely to find on today's computers.

Chapter Outline

Lesson 5–1
Understanding Computer Storage

Lesson 5–2
Classifying Storage Devices

Lesson 5–3
Common Storage Devices

Lesson 5–1

Understanding Computer Storage

Objectives

- Explain the need for storage devices for computers.
- Distinguish between memory and storage.
- Distinguish between storage devices and media.

As You Read

Organize Information Use an outline to help you organize information about computer storage and storage devices as you read.

Key Terms

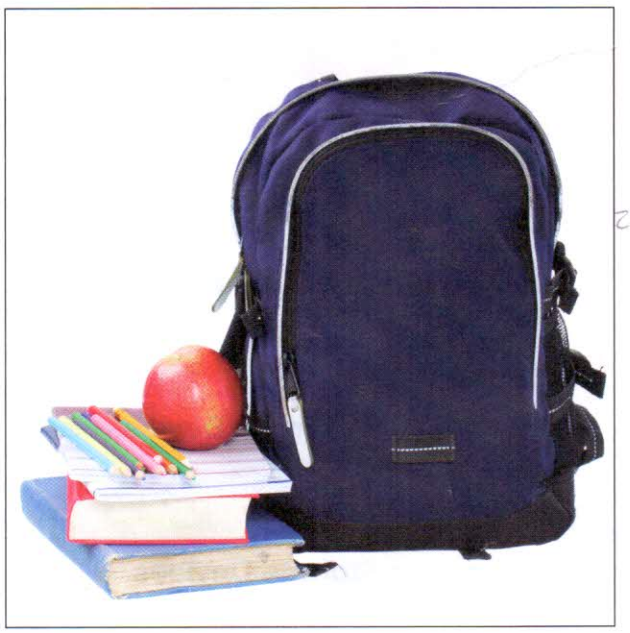
- backup
- Basic Input/Output System (BIOS)
- file
- firmware
- memory
- restore
- storage device
- UEFI (Unified Extensible Firmware Interface)

Computer Storage Devices

Where do you store the books, pencils, and notebooks that you need for school? Many students keep them in a backpack. When class is about to begin, they pull out the items they need. When class is finished, they put the items back into their backpacks.

This is similar to the way **storage devices** work. They are the computer's hardware components that retain data even after the power is turned off. Suppose you turned off your computer without saving your work to a storage device. All your work would be lost. Without storage devices, you would have to re-create all of your work every time you wanted to use it.

Why not keep all of a computer's software and data available at all times? Because no one needs to use every program or file every time they work on the computer. For example, you might be doing word processing today, but creating a computer drawing tomorrow. There is no need to have both programs open at the same time if you are not using both of them.



Files A computer stores data and program instructions in files. A **file** is a collection of related information or program code, which has been given a unique name.

Figure 5.1.1 Like a backpack, a computer's storage devices hold things until you need them.

The type of file people most often use is called a document. A document can be any kind of file that a user can create, save, and edit. For example, you can use a word-processing program to create a letter, which is one type of document. A digital photo is another type of document.

System Startup Computer storage devices are a key part of a computer's startup process. Without a storage device to hold startup information permanently, a computer would not know what to do when you turned it on.

When you start a computer, it looks for information that tells it what to do. The **Basic Input/Output System**, or **BIOS**, is a set of programs, called **firmware**, that tells the computer equipment how to start up. When a computer is built, the BIOS is set up with this basic information. The BIOS is permanently stored in special memory chips called read-only memory, or ROM. Usually, the BIOS instructs the computer to look for the operating system. The operating system contains all the commands required to run the computer. It provides the tools to operate the system and to run programs. Most Apple Macintosh computers and personal computers built to run Windows 8 and later use **UEFI (Unified Extensible Firmware Interface)** instead of BIOS. UEFI allows for faster startup, supports large capacity storage drives, and is more secure than BIOS.

Memory and Storage

When people talk about computer **memory**, they usually mean a set of chips that acts as a temporary workspace in the computer. This memory, called random access memory, or RAM, stores data and program instructions needed by the CPU.

RAM and ROM are different in two important ways, as the following chart shows. First, ROM is nonvolatile, which means it stores its contents permanently, even when the computer is turned off. RAM, on the other hand, is volatile and only stores its contents temporarily; if the computer loses power, RAM's contents are lost.

Second, because ROM stores instructions that are needed only by the computer, you seldom need to think about ROM or the information it holds. But RAM holds data and programs while they are being used. As you use the computer, you constantly work with the contents of RAM.

Connections

Science Nanotechnology is a field of science and technology that studies how to make things by arranging individual atoms and molecules. Nanotechnology has contributed to advances in computer technology.

For example, nanotechnology has made it possible for computer hard drives to hold ever larger amounts of data. They can do so because the parts that retrieve and record data—called the read/write heads—are made from an extremely thin layer of magnetic material. The material is less than one billionth of a meter thick, or close to 7,000 times thinner than a strand of a spider web.

ROM and RAM

	Storage	Holds
ROM	Permanent	Startup instructions and configuration information for the computer
RAM	Temporary	Program instructions and data that are being used by the CPU

Did You Know?

Most computers only have enough RAM to store programs and data while a computer is using them. This is because RAM is relatively expensive to make and to buy. As a result, makers of computers limit the amount of RAM in their machines to help lower initial computer costs and to allow users who want more RAM to purchase it separately.

1KB = 1000 Byts
1MB = 1,000,000 Byts
1GB = 1,000,000,000 Byts
1TB = 1,000,000,000,000 Byts
1PB = 1,000,000 GB

Storage Versus Memory New computer users sometimes get confused about temporary memory (RAM) and permanent storage (disks and disk drives). They will say "memory" when they actually mean to say "storage." Adding confusion, both are measured with the same units: bytes. One byte equals about 8 bits, or a single character. A kilobyte, or 1KB, is 1 thousand bytes. A megabyte, or 1MB, is 1 million bytes. A gigabyte, or 1GB, is 1 billion bytes. A terabyte, or 1TB, is 1 thousand billion bytes. A petrabyte, or 1PB, is one million gigabytes. To avoid this problem, remember two key differences between storage and memory:

- The two work differently. Remember that RAM uses chips to temporarily store information. These chips depend on a constant supply of power to keep their contents; when the power is lost, the chips lose their contents. Storage uses different methods to store data permanently, so it isn't lost when the power is turned off.
- A PC has more storage capacity than memory. Even though some PCs have several gigabytes of RAM, their hard drives will be many times larger.

Storage Media and Storage Devices

Storage has two components: storage media and storage devices.

Storage Media In terms of storage, a medium is an object that physically holds data or program instructions. Flash drives, magnetic tapes, compact discs, DVDs, and Blu-ray Discs are examples of storage media. (The word *media* is the plural of *medium*.) One important use of storage media is for making a **backup** of computer data. When you back up data you copy the data to a different location for safekeeping. If the original data is lost or damaged you can **restore** the data from the backup files.

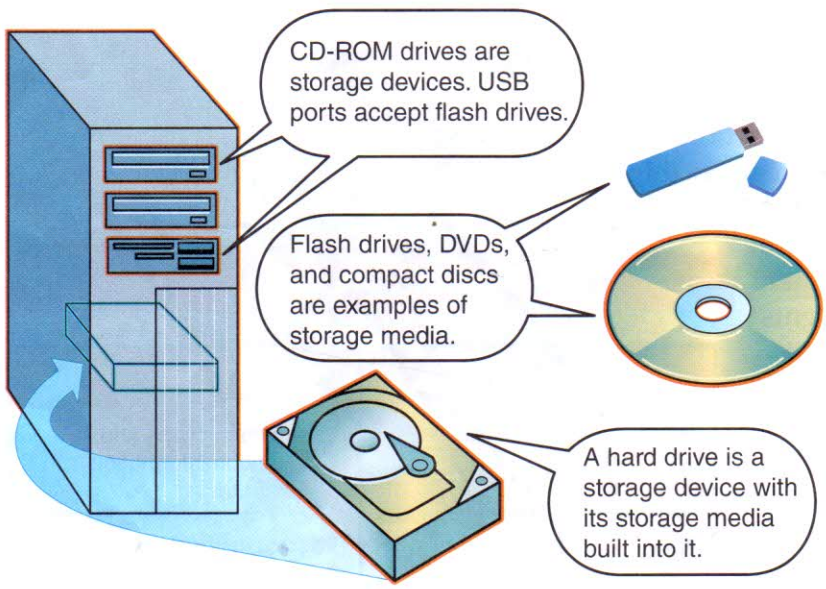


Figure 5.1.2 Nearly all PCs use the storage devices and media shown here.

Storage Devices A storage device is a piece of hardware that holds the storage medium, sends data to the medium, and retrieves data from the medium. Hard drives, flash drives, and CD and DVD drives are all examples of storage devices.

Classifying Storage Devices

Lesson 5–2

Objectives

- Explain how computer storage devices are classified.
- Compare and contrast primary, secondary, and archival storage devices.
- Describe the categories of storage devices.

As You Read

Classify Information Use a spider map to help you classify storage devices as you read.

Hierarchy of Storage Devices

Computer storage devices are sometimes classified in a hierarchical structure—that is, primary or secondary.

Primary Storage Devices The term **primary storage** is sometimes used to describe the main memory, or RAM, in a computer. This is because when the CPU needs data or instructions, it looks in memory before looking anywhere else.

Most knowledgeable computer users, however, avoid using the term *storage* when talking about RAM. This is because RAM works very differently from storage devices such as disks or flash drives. RAM also loses any data it contains when the computer is turned off, while disks and flash drives can hold data permanently.

Secondary Storage Devices The term **secondary storage** is sometimes used to describe devices that can store data permanently, such as a hard drive, flash drive, compact disc, DVD, or external hard drive. This is because the computer will look for data on one of these devices if the data is not in RAM.

Many kinds of secondary storage devices can hold much more data than a computer's RAM can. For example, while most of today's PCs have from 4 to 16 gigabytes of RAM, they have hard drives that can store up to a terabyte.

Because they can store data permanently (or until you erase it), secondary storage devices are sometimes called **archival storage devices**. This refers to the fact that you can store data on a drive or disk and then put it away for a long time, only using it again when you need it.

Key Terms

- archival storage device
- optical storage device
- primary storage
- random access storage device
- read/write device
- read-only device
- secondary storage
- sequential storage device

Figure 5.2.1 Compact discs and digital video discs are popular storage media.

Technology @ Home

You probably use a variety of storage devices in your home. Some of these may be computerized, while others are not.

Think About It!

Some of the devices listed below are based on read-only technology, while others are based on read/write technology. Which storage devices in the list do you think are based on read-only technology?

- Smart phone
- CD-ROM drive
- CD burner
- DVD-ROM drive

Categories of Storage Devices

Storage devices (but not RAM) are divided into three categories. Each category has two options based on the device.

Read-Only Versus Read/Write A **read-only device** can only read data from the storage medium. You cannot change the data on the medium or save new data onto it. A CD-ROM drive is an example of a read-only device, because it does not have the capability to write data onto a disc.

The media used with read-only devices come with data already saved on them. Music CDs or software programs on CDs are CD-Rs. Your CD-ROM drive will be able to play the music or read the program instructions from the disc, but you can't change the disc's contents. Standard DVD players are another example of a read-only device.

A **read/write device** not only can read data from the storage medium, but can write data onto the medium, as well. These devices let you read data from a disk or tape, make changes to the data, and save new data onto the medium. Hard drives, USB flash drives, CD-Rewritable drives (CD-RW), and DVD-RAM drives are commonly used examples of read/write devices.

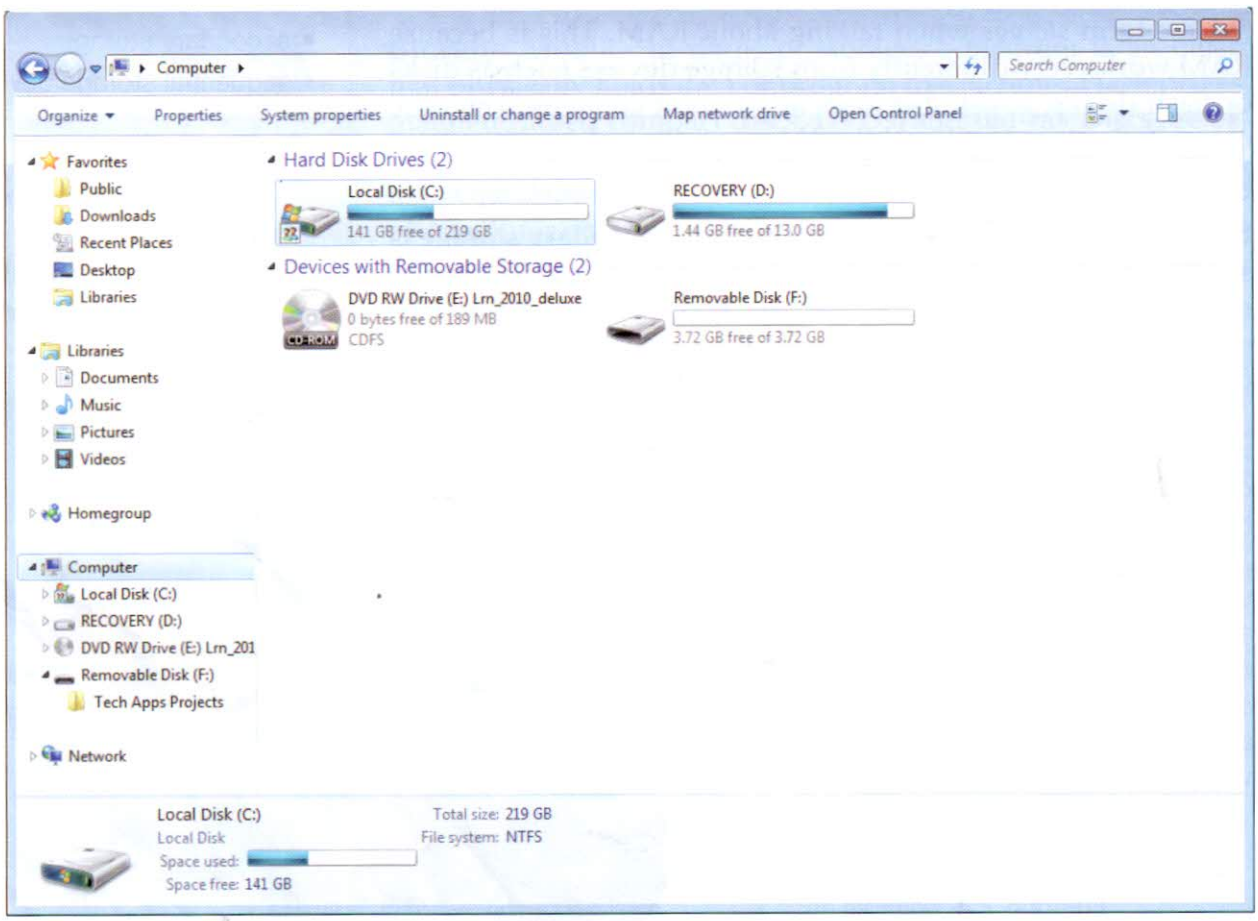


Figure 5.2.2 Use an operating system such as Windows to view a list of storage devices connected to your computer.

Sequential Versus Random Access When equipped with a tape drive, business computers can store data on a long piece of tape, similar to an old-fashioned cassette tape. A tape drive is an example of a **sequential storage device**, which requires the computer to scan from the beginning of the medium to the end until it finds the data it needs. While cheaper and slower than other types of storage, the highest capacity tape cartridges can hold five terabytes of uncompressed data. Because it can take several minutes to locate a piece of data on a high-capacity tape, tapes are used chiefly by businesses that want to back up their computer systems—often after the business day is over.

A **random access storage device** lets a computer go directly to the needed information. The device does not have to search the entire medium to find data. For this reason, random access storage devices are much faster, and more expensive, than sequential devices. A hard drive is an example of a random access storage device.

Magnetic Versus Optical Storage Magnetic storage devices are specially treated disks or tapes, such as those mentioned above, that record information using magnetically sensitive materials. These devices use electricity to shift magnetic particles so they form a pattern that the computer reads and stores as information. Common magnetic storage devices include hard drives and tape drives

Other storage devices use laser beams to read information that has been stored on the reflective surface of a disc. These are called **optical storage devices**. Popular types of optical storage devices for computers include CD-ROM and DVD-ROM drives.

Technology @ School

Some schools have a dedicated computer "lab," but more and more schools have computers in every classroom or tablets for every student. Expensive equipment may be damaged if a student mishandles it, costing the school—or the student—money to replace it.

Think About It!

Rate the computer equipment that you think is most sensitive to mishandling and needs the most care. On a scale of 1 to 5, use 1 for most sensitive and 5 for least.

- CD-ROM/DVD
- Flash drive
- Hard drive
- Power cord
- Laser printer
- Tablet

Spotlight on...

HIGH-CAPACITY PORTABLE STORAGE

Devices such as Apple's iPod Touch and Sony's Walkman MP3 player function as both MP3 players and as high-capacity, portable storage devices.

By plugging them into a computer, you can use these tiny storage devices to download files or transfer information from one computer to another. Some models can store 64 GB of data. (That's at least 14,000 songs or up to 80 hours of continuous video!) Yet, they are the size of a deck of cards and weigh $\frac{1}{2}$ to 3 ounces, and they are getting smaller in size and larger in storage all the time.

Smart phones, such as Apple's iPhone or Motorola's Droid, offer storage capabilities along with phone service.

Lesson 5–3 Common Storage Devices

Objectives

- Differentiate between internal and external storage devices.
- List commonly used magnetic storage devices.
- Summarize optical storage options.

As You Read

Classify Information Use a T-chart to help you classify information about magnetic and optical storage devices as you read.

Key Terms

- CD-ROM drive
- hard drive

Internal and External Storage Devices

Storage devices can be installed in your computer or connected to it. A storage device installed inside your computer is called an internal storage device. One that is positioned outside your computer is referred to as an external storage device.

Magnetic Storage Devices

The most common magnetic storage device installed in computers is a **hard drive**. You cannot see the hard drive because it is installed inside your computer. Often, a small flashing light on the front of a computer shows when the hard drive is in use. Hard drives hold a great deal of data, but they are not portable.

External Magnetic Devices Other forms of magnetic storage devices include a variety of USB- or firewire-connected external hard drives. These can hold up to as much as 8 terabytes of data, and they are portable. External drives communicate with the computer via a high-speed interface cable. By using the external hard drive with an automatic backup program, like the Mac's TimeMachine, computer users have peace of mind. They know their data is always recoverable if their computer crashes or is hit by a virus.

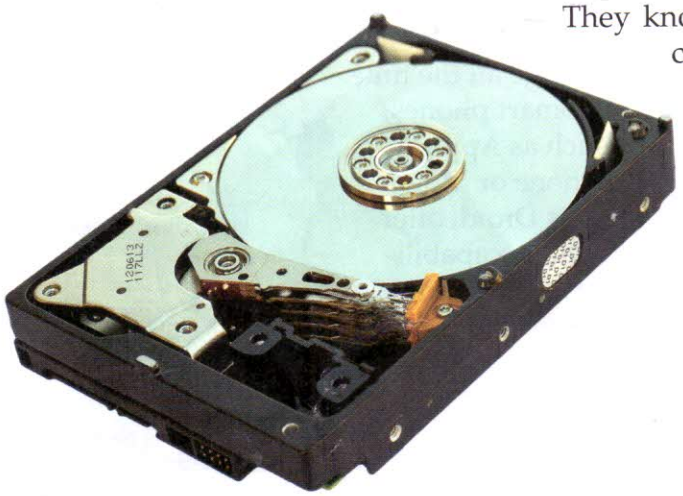


Figure 5.3.1 If you removed a PC's internal hard drive, it would look something like this.

Magneto-Optical (MO) Drives A popular method of data storage for many businesses, this type of drive combines both magnetic and optical drive technologies. A magneto-optical drive uses a removable disk that is inserted via a slot in the front of the drive. These drives can be internal or external. Their disks can store several gigabytes of information.

Online Storage Many online—or cloud—storage sites such as Google Drive, Dropbox, Microsoft OneDrive, and Apple iCloud, are available where you can store files on a network server at a remote location. You access your data by logging in through the Internet using a secure password. Some programs, including Microsoft Office, come with free online storage space. You can also pay a storage service provider (SSP) for space. Online storage offers these three benefits: 1) it is expandable; 2) it allows you to share files with others; and 3) data stored in a remote location is protected if your computer is stolen or damaged.

Capacities of Common Storage Devices

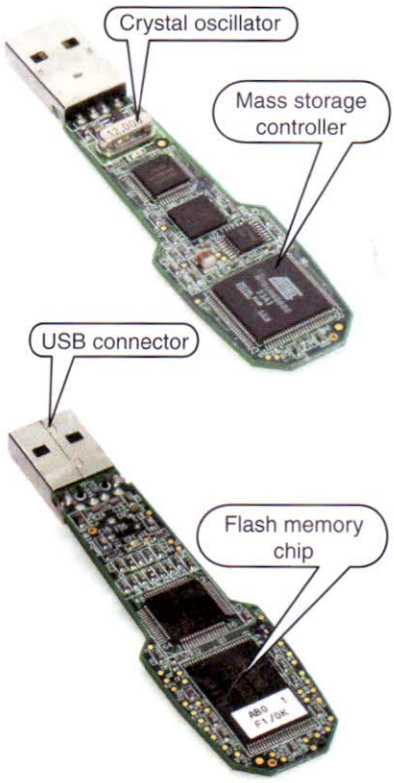
Device	Capacity
Internal hard drive	500 GB–1 TB and more
External hard drive (USB or Firewire connection)	500 GB–8 TB and more
MP3 player	16 GB–64 GB and more
Smart phones	128 GB flash storage
Magneto-Optical (MO) drives	100 MB–several GB
Flash memory cards and drives	4 GB–256 GB and more
CD-ROM	650 MB–700 MB
DVD	9.5 GB
Blu-ray disc	25 GB

Career Corner

Computer Security Specialist
Today, security specialists are in demand to work with various computer storage systems, such as tape warehouses and online storage companies.

Computer security specialists study ways of improving the overall security of their systems. For example, some goals include improving recording or access time or the safety of the protected information in case of a natural disaster.

Figure 5.3.2 A USB flash drive has a USB connector, a flash memory chip, a mass storage controller, and a crystal oscillator that allow the device to communicate with the computer.



Technology @ Work

Businesses protect their data by backing up their saved files. Experts recommend having two backups—one at the worksite and one in a different location.

Think About It!

Think about why a business might need to store its backups at a completely different site. Which disasters listed below might destroy a backup if it were kept on-site?

- fire
- flood
- earthquake
- break-in
- tornado

Flash Memory Storage Devices

Flash media use a non-magnetic storage medium called flash memory. Flash memory is a special kind of storage used in ROM chips within your computer itself to store basic information about the computer's configuration. It is also used in memory cards and memory sticks for digital cameras that require removable, reusable storage and in USB flash drives (also called jump, pen, and key drives). Flash drives connect to the computer through a USB (universal serial bus) port.

Most removable flash memory devices include a chip that stores data and a microcontroller that permits the operating system to communicate with the chip. As the technology of flash memory improves, the capacity of flash devices increases significantly. Early flash devices only held 32–256 MB, but capacities of up to 512 GB are now available but very expensive. The small size, increasing capacity, and ease of connection of these removable devices make them widely used.

Optical Storage Devices

Optical storage devices store data by etching tiny pits onto a disc. A laser then scans the disc and changes the data into a form the computer can work with. CDs, DVDs, and Blu-ray Discs are the most common types of optical storage media. On a PC, a button on the front of the drive opens a tray on which you insert a CD. You push the button to close the tray so you can read the disc's contents. On Macs the **CD-ROM drive** is simply a slot into which you insert a disc, and you can eject it electronically by moving the disc icon into the "trash."

Standard CD-ROM and DVD drives can only read data stored on an optical disc. Only optical drives labeled CD-R, CD-RW, or DVD/CD-RW can be used to record data onto blank discs.

A standard CD can store 650 megabytes of data, or around 74 minutes of audio. Newer CDs can store 700 megabytes of data, or about 80 minutes of audio. Digital video discs can store about 4.7 gigabytes of data on each side. These discs are used for storing programs, games, data, and movies.

Figure 5.3.3 CDs and DVDs are popular components in both computers and home entertainment centers.

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

F 1. storage device
A 2. memory
B 3. primary storage
J 4. secondary storage
D 5. read/write device
G 6. random-access storage device
C 7. optical storage device
E 8. hard drive
I 9. read-only device
H 10. CD-ROM drive

a. temporary workspace on a computer
b. sometimes used when referring to a computer's RAM
c. uses laser to read information
d. users access from and save information to this type of device
e. common secondary storage device
f. computer component that retains data even after power is shut off
g. storage device that lets computer go directly to the needed information
h. read-only optical device
i. can only read data from the storage medium
j. any type of storage device that holds data permanently; not RAM

Check Your Comprehension

Directions: *Complete each sentence with information from the chapter.*

1. Storage devices store information even when a computer is turned off.
2. Information saved as a(n) File is identified by a unique name.
3. The BIOS is a set of programs that directs a computer to start up.
4. RAM stores its contents Temporarily and is cleared when the computer is shut down.
5. A computer's BIOS is usually stored in a special memory chip, called ROM.
6. Apple's iPod is an example of Devices that stores data in the popular MP3 format.
7. The most common secondary storage device is a(n) hard drive.
8. Archival storage allows users to access rarely used computer files.
9. A magnetic tape is an example of a(n) Sequential storage device.
10. Online storage lets you store data on a remote computer.

Think Critically

Directions: *Answer the following questions.*

1. Which type of secondary storage device do you use most at school? Do you think this will change in the near future? If so, why?

2. What can you do with a CD-RW that you cannot do with a CD-R?

3. Why do you think computer hard drives locate information directly, rather than sequentially?

4. What are the ways in which computer users would use a CD-ROM drive at home? At work? At school?

5. Where do you think users of computer games sold on CDs and DVDs store their information? Why?

Extend Your Knowledge

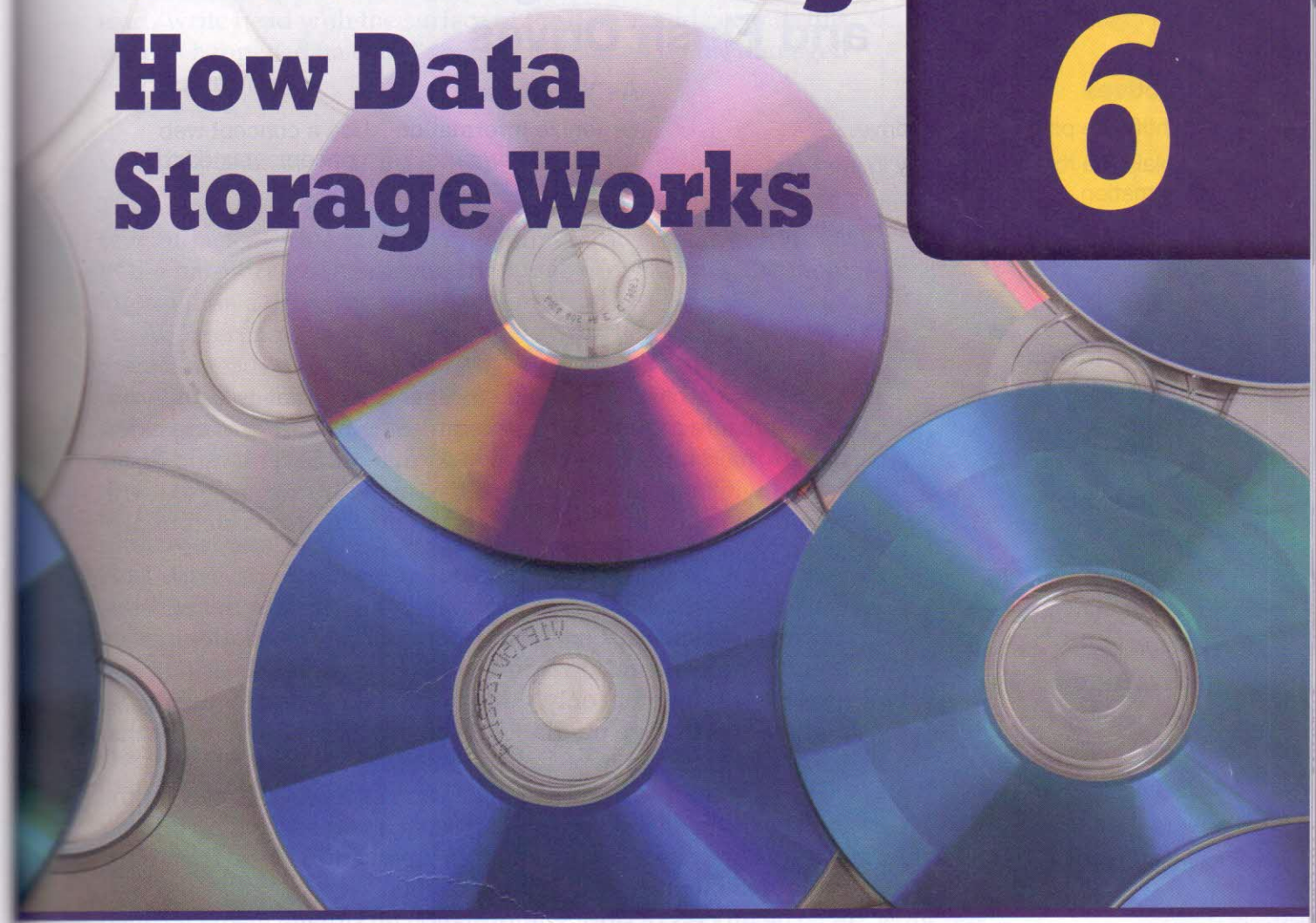
Directions: *Choose and complete one of the following projects.*

A. Look at your computer at school and find out how much memory it currently has. Next, use online documentation or other resources, such as the manufacturer's Web site, to compare your computer memory to the maximum amount of memory your computer can hold. Identify advantages to having more random access memory and compare this to the cost. As a class, conclude whether or not your school computers have sufficient memory to meet students' needs.

B. Go online and do research on storage service providers. Take notes and keep track of your sources as you work. Be sure to evaluate the information and only use it if it is accurate, relevant, and valid. What services and features do they offer? How do they protect the data they store? How easy is it for customers to access their data once they have given it to the service? Can customers share the stored data with other people? What fees do these services charge? Do you think such services can be useful to individuals as well as to companies? Discuss your findings with a partner, or as a class.

Understanding How Data Storage Works

chapter 6



Why Is Computer Storage Important?

Once you understand the basics of computer storage, you can begin to understand why storage is so important. In fact, the true power of a computer is its ability to store data for future use. Without storage, a computer would be similar to a calculator; useful for a one-time task, but not much more than that.

In this chapter, you will examine how different types of storage devices work. You will learn more about the advantages and drawbacks of storage devices, and the steps you can take to protect your data.

Chapter Outline

Lesson 6–1

Understanding Hard Drives and Flash Drives

Lesson 6–2

Optical Storage Devices

Lesson 6–3

Storage Trends

Lesson 6–1

Understanding Hard Drives and Flash Drives

Objectives

- Identify the parts of a hard drive.
- Explain the role platters play in storing information.
- Compare and contrast the access time of different storage devices.

As You Read

Organize Information Use a concept web to help you organize key concepts related to hard-drive storage as you read.

Key Terms

- access time
- cylinder
- data loss
- flash memory
- platter
- property
- read/write head
- sector
- solid state disk (SSD)
- storage media
- track
- USB flash drive
- write
- write-protect switch

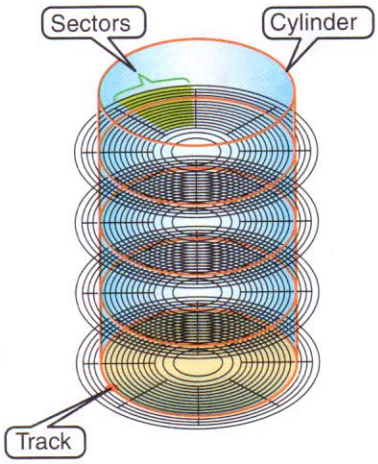


Figure 6.1.1 In a stack of platters, the same track creates a cylinder.

Parts of a Hard Drive

Recall that a hard drive is a storage device that is usually installed inside a computer, although some hard drives are external. Its main function is storing information. Several rigid disks, coated with a magnetically sensitive material, are enclosed with recording heads in a hard metal container that is sealed to protect it from dirt and other damaging items.

Platters Inside the sealed container is a stack of metal disks, known as **platters**, that store information. The platters rotate around a spindle inside the sealed container. These platters are so close together that only a thin layer of air separates them. The platters are **storage media**, coated with a special material that allows information to be saved on them.

Each platter is divided into **tracks**, or a set of circles on the surface of the platter, on which the data is recorded. A **cylinder** is the same track location on all the stacked platters. Each track is divided into segments, called **sectors**.

The process of storing information on storage media is called **writing**. Information can also be deleted from the platters. This is done when you no longer need a file or want to make room for another one.

Read/Write Heads A hard drive has a motor that spins the platters at a high speed. Usually, these platters spin continuously when your computer is on. A small, needle-like component, called the **read/write head**, travels back and forth across the surface of each platter, retrieving and storing data. Most hard drives have at least one head on the top and one on the bottom of each platter for storage on each side of the platter.

Storing Data on a Hard Drive

When a file is saved to the hard drive, the read/write head locates a spot on a platter. It then generates a magnetic field on the surface of the platter. The magnetic field records a string of 1s and 0s, or binary code, to generate the information a computer can read.

If the hard drive is damaged or if the read/write head changes the field in order to modify or delete the file, the magnetic field will not remain intact. A head crash, or the collision of a read/write head with the surface of the disk, could occur. If this were to happen, data could no longer be stored on the damaged sector of the drive.

Limitations of Hard Drives

The amount of information a hard drive can hold depends on several factors. One factor is the number of platters contained in the hard drive. The greater the number of platters, the more information a drive can store.

Another factor is the number of read/write heads. Generally, there is a read/write head for each side of each platter. However, sometimes one side of one platter will not have its own read/write head. That means information cannot be stored on that side.

Effects of Performance The performance of your hard drive directly affects how fast your computer works. The faster the hard drive, the faster your computer will read and write data. Because the platters in a hard drive are rigid, they can spin at very high speeds. The platters in most hard drives can spin at a rate of 7,500 rpm (revolutions per minute), but some can spin at rates as high as 15,000 rpm.

Hard Drive Speed A storage device's most important performance characteristic is the speed at which it locates the desired data. This is measured by its **access time**, the amount of time it takes for the device to begin reading the data. For hard drives, the access time includes the time it takes the read/write head to locate the data before reading begins.

The speed of storage devices varies considerably, but all storage devices are significantly slower than RAM. RAM speed is measured in nanoseconds, or billionths of a second. A storage device's speed is measured in milliseconds, or thousandths of a second.

Hard Drive Capacity The first PC hard drives held only about 10 MB of data and program instructions. Recent personal computers feature hard drives with capacities of 500 GB and higher—you can even buy hard drives with capacities of 1 to 3 terabytes!

Alternative Storage Options

Manufacturers of computer chips are working to provide faster alternatives to magnetic storage.

Connections

Mathematics In math class, you are accustomed to a system that combines ten possible digits, or numbers, in a certain order to represent larger numbers. In binary code, only 0 and 1 are used.

- In math class, you carry a number over to the next column when numbers in a column add to 10 or more. With binary numbers, a number is carried if the items add to 2. In an eight-bit example, the number 35 would be written as 100011.
- While numbers in math class refer to specific quantities, binary code numbers refer to specific actions. A 1 turns a circuit on, while a 0 turns a circuit off.

Solid State Disks **Solid state disks** or drives, or **SSDs**, are a mass storage device similar to a hard disk drive. Even though SSDs serve the same purpose as hard drives, their internal parts are much different. SSDs do not have any moving parts, like the hard drive's magnetic platters; they store data using flash memory. SSDs have better read performance because the data does not get fragmented into many locations, and, since they are not magnetic, SSDs do not lose data when next to a strong magnetic field.

SSDs do have disadvantages, though. This newer technology costs about ten times more per gigabyte, so people tend to buy SSDs with smaller capacity than most hard drives. Their limited number of write cycles means their performance declines over time. Yet, with improvements in SSD technology, these devices will advance, and the prices may come down.

Flash Memory Devices Several types of storage devices using flash memory offer the speed of memory with the high capacity of a magnetic storage device. Flash memory drives work faster than magnetic drives, because they have no moving parts, and they do not require battery power to retain their data. Flash drives installed inside computers resemble magnetic hard drives in size and shape.

A **USB flash drive** is a portable, self-contained storage device that uses **flash memory**. In addition to portability, these drives offer the advantages of speed, capacity, and cost. A USB flash drive has a USB connector that plugs into the USB port on a computer; a flash memory chip that stores data; a USB mass storage controller that allows the computer to read, write, and erase data on the drive; and a crystal oscillator that controls the speed with which the drive works.

The electronic parts of the flash drive are protected by a hard plastic or metal case. The USB connector usually has a cover to protect it as well. Most USB flash drives have a light that comes on when the drive is plugged in. The drive may have a **write-protect switch**. When the switch is in the on position, the computer can read from the drive but cannot write to it or delete data from it.

Protecting Your Information

The information saved on computer storage media is important to the individuals, schools, businesses, and government agencies that wanted to keep it. Computers store information about virtually every aspect of life. We use them to store school grades, lists of business contacts, names of registered voters, bank account balances, and many other kinds of crucial data. Since this information can be so important, computer users should be aware of data loss and protection.

Data Loss When a storage device experiences **data loss**, the data is damaged or made unusable. Storage devices and computers can also be lost, stolen, or destroyed, resulting in data loss. The data may be gone forever. It may be time-consuming or impossible to reconstruct the information that had been stored.

Data Protection One way to reduce the impact of data loss is to back up your data. Storing information on removable storage media, which may be locked in high-security areas or stored at a different location, makes it difficult for people to steal the information, or to lose it due to a disaster such as fire, flood, or system failure. Many businesses use magnetic tape to back up large amounts of data, because it is relatively inexpensive and reliable. Some organizations hire storage service providers, or SSPs, to store data on offsite computers, and online storage is becoming increasingly popular.

Information can also be accidentally deleted, overwritten, or stolen by unauthorized users. One way to protect data is to apply password protection to a file or drive so only authorized users can access it, or to set a read-only property so the data may be read but cannot be changed. A **property** is a piece of data, sometimes called metadata, attached to or associated with a file, program, or device. Typical properties include name, type, storage location, and size. You can view and customize properties in the Properties dialog box.

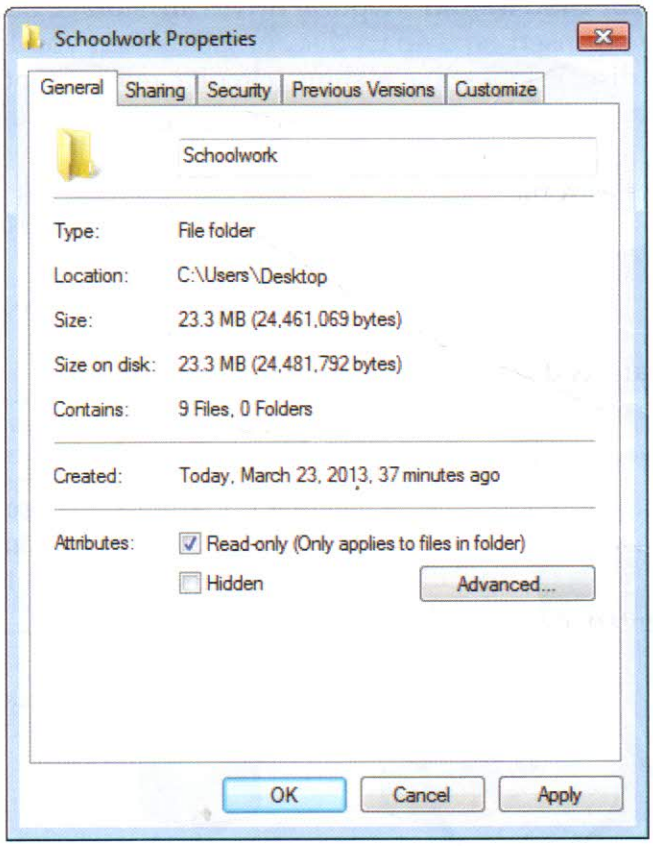


Figure 6.1.2 To keep a file from being changed or overwritten, you can set its properties to Read-only.

Technology @ Home

Natural disasters present a threat to computer information stored at home. Even if you back up your information using standard methods, backups typically are stored in the home and are likely to have suffered the effects of the disaster.

Think About It!

Choosing the right backup system can mean the difference between being able to retrieve lost information and never being able to find it. Which backup storage methods below might survive a fire at home?

- store in a home safe
- store in a drawer at work
- store next to the computer
- send as e-mail attachments to a remote computer
- store on the hard drive in a different folder

Lesson 6–2 Optical Storage Devices

Objectives

- Compare and contrast CD-ROM and DVD-ROM drives.
- Summarize how compact discs and digital video discs store data.

As You Read

Organize Information Use a spider map to help you organize information about optical storage devices and how they work as you read.

Key Terms

- data transfer rate
- land
- laser sensor
- pit

CD-ROM and DVD-ROM Drives

The most recent advancements in storing data are in optical storage. These include CD-ROM (compact disc read-only memory), DVD-ROM (digital video disc read-only memory), laserdiscs, PhotoCDs, and similar storage devices. Optical storage media—the discs themselves—are easy to transport and can store large amounts of information. Many computers have built-in DVD or Blu-ray drives, or ports for connecting external drives. In part to distinguish optical media from magnetic media, some people prefer changing the spelling of disc (optical) to disk (magnetic).

Compact Disc Media Optical drives are storage devices into which you insert a compact disc, or CD. When you look at an optical disc, it looks like a shiny, circular mirror. Optical discs are made up of three layers. The bottom layer is a clear plastic. The middle layer is a thin sheet of aluminum. The top layer is a lacquer coating that protects the disc from scratches and dust.

Figure 6.2.1 You can use a computer's built-in DVD or Blu-ray drive to install programs, watch movies, back up files, or play audio.

Reading Optical Information

All storage devices read information at a speed measured by the unit's **data transfer rate**, or the number of bits of data the device can transfer to memory or to another device in a single second. In CD-ROM drives, the speed is measured in a multiple of 150,000 bits—the speed per second of the first CD-ROM drives. A 2X drive transfers data at double speed, or 300,000 bits per second. Some drives transfer data at 7.8 million bits per second, about as fast as slower hard drives.

Laser Sensors A **laser sensor**, a laser-operated tool that reads information, is housed inside the optical drive. Optical drives read information by shining a laser on the disc in the drive. A laser sensor starts to read from the center of the disc's spirals and moves outward. The sensor notices changes in the physical properties of the disc and reads these changes as binary code: 0s and 1s.

Lands and Pits The surface of an optical disc stores data as a series of lands and pits. A **land** is a flat, reflective area on the surface of a disc. Lands reflect light from a laser's sensor and are recorded as a 1 by a computer. A **pit** is an indented area on the surface of a disc that scatters the light from a laser's sensor. Since no light is reflected by a pit, it is recorded as a 0. The binary code represents the information encoded on the surface of the disc.

Technology @ Work

Because information storage is important to many businesses, a growing number of companies are using DVDs to store large amounts of information.

Think About It!

Which of the following businesses might need the storage capacity of DVDs to record their business transactions?

- graphic-arts firm
- dry cleaner
- grocery store
- insurance company
- auto repair shop

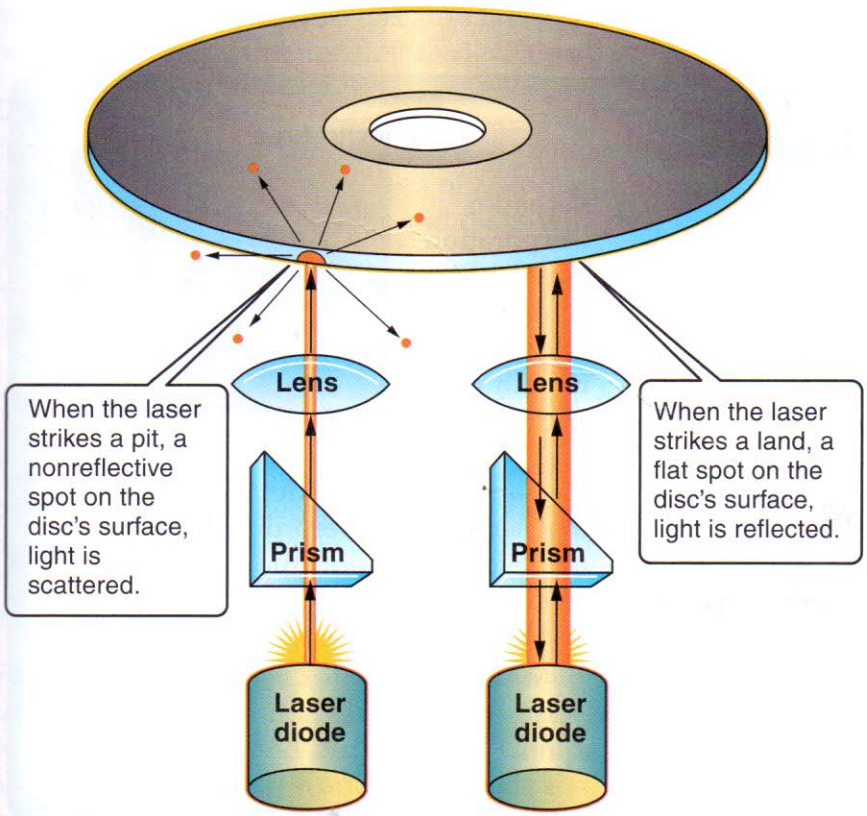


Figure 6.2.2 How an optical drive reads data on an optical disc.

Did You Know?

In the first decade of this century, there was a battle for dominance between Blu-ray Disc™ or BD™ and HD DVD™ formats for DVD.

At that time it was not known which of these formats would win out and be used by most high-definition DVD players.

In February 22, 2008, the battle ended when Toshiba announced it would stop manufacturing the HD DVD player. Both of the formats were invented to take the place of DVDs that didn't have enough storage for what is called "hi-def" video. Dual-layer BDs can hold up to 9 hours of HD video or 23 hours of standard definition (SD) video. Even though dual-layer HD DVDs held slightly more video than BDs, the Sony Play Station 3 contained a BD player for primary storage, and that is how the war for market domination was won!

Storing Optical Information

CD-ROM, laserdisc, and DVD-ROM drives are read-only devices. CD-R, CD-RW, and DVD-RAM drives read *and* write information.

CD-R Drives These drives let you insert a blank recordable CD and then save data to it. After the information is stored, the disc's surface is changed so that the recorded information cannot be changed or erased.

CD-RW, DVD-RAM, DVD-R/RW, and PhotoCDs Optical devices that let you record, change, or overwrite data multiple times are called read/write storage devices. CD-RW, DVD-RAM, and DVD-R/RW drives provide read/write capabilities using erasable discs. The information on that disc can be deleted after it is written, and additional information can be added. PhotoCDs can save photographs from the Internet and from digital cameras.

Spotlight on...

VERBATIM CORPORATION

"It won't take consumers long to realize that the new dual-technology drives not only provide a huge amount of removable storage capacity for photo albums and videos; they provide added value because the same drive can be used to store, edit, back-up, archive, and share documents, data, and other personal/professional information."

Jon Peddie, Market analyst

Verbatim Corporation was the first company to offer DVDs in both write-once and read/write formats. A patented Metal Azo dye that serves as the recording layer for the discs has become the main dye used for write-once DVD devices. It also provides the fastest recording speed of any of today's DVD formats.

Storage Trends

Lesson 6–3

Objectives

- List limitations of current storage technologies.
- Compare solid-state storage devices to magnetic and optical storage devices.

As You Read

Identify Key Concepts Use a spider web to help you identify key concepts about future storage devices as you read.

Limitations of Storage Devices

All technologies change over time. Technological breakthroughs have helped correct these common storage-device problems:

- slow retrieval
- data decay
- friction

Slow Retrieval Tape devices are limited by slow retrieval speeds. Because devices must search from the beginning to the end of the tape to find the data, and magnetic tape cannot spin as fast as hard drives, it can take several minutes or even hours to locate information. Also, because tapes are usually stored in a remote location, you must first retrieve them.

Data Decay One limitation of current storage devices is the possibility of **data decay**, or the loss of information resulting from the gradual wearing down of a storage medium. Information stored on magnetic tapes and disks will, over time, become unusable. Air, heat, and humidity can break down the surface of magnetic storage media. As this breakdown occurs, the information stored may be lost.

People once thought optical storage devices did not decay. However, studies have shown that user-recorded discs can lose information in as few as five to ten years. Factory-recorded, or pressed, compact discs may decay in 10 to 25 years. In addition to being vulnerable to gradual decay, magnetic storage devices can lose data in an instant if exposed to a strong magnetic field.

Friction As a magnetic tape travels through the tape heads, friction is created. This causes heat, which can stretch and burn a tape. Companies are trying to develop read/write heads that decrease this friction and preserve magnetic media.

Key Terms

- cloud computing
- data decay
- data integrity
- enterprise storage system
- holographic data storage system (HDSS)
- storage area network (SAN)
- virtualization

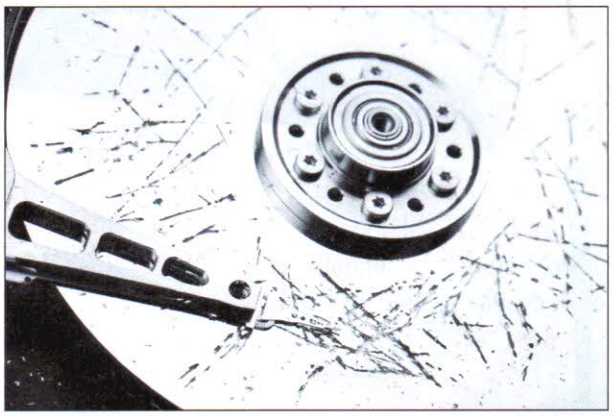


Figure 6.3.1 Time and environmental conditions can take their toll on any storage medium.

Connections

Science You may have learned about solid-state technology in science class. However, that definition may be different from what you associate with solid-state storage devices.

- One definition of *solid state* refers to the properties of solids. These can include the electrical forces of solids as well as their magnetic currents.
- A second definition refers to the levels of heat inside a piece of equipment, which are controlled by electronic devices, such as semiconductors.

Devices such as digital recording equipment and laptop computers have their heat levels controlled by electronic devices, thereby fitting the second definition of *solid state*.

Data Integrity

When information is stored, it must be maintained correctly. **Data integrity** means that stored information is usable and available in the location in which you expect to find it. Data integrity can be maintained using RAID, Redundant Array of Inexpensive Disks.

RAID is a term used to describe a collection of drives or disks that run together to store data. For example, a computer using RAID may have two or more hard drives installed. The hard drives work together as one to read data from and write to the drive at the same time. This backup process ensures that copies of files can be retrieved in case one drive fails.

Enterprise Storage

Computers linked together by a cable or wireless medium are called networked computers. In a network environment, computers can share data using an **enterprise storage system**. This technology allows networked computers to access storage devices linked to the network, such as servers, RAID systems, tapes, and optical disc systems.

New and Future Technologies

As computer use increases, the need also grows for faster, more reliable, and higher capacity storage.

Cloud Computing and Virtualization Both cloud computing and virtualization make computers more efficient by using centralized storage, memory, and processing. **Cloud computing** uses the Internet and central remote servers to host data and applications.

Figure 6.3.2 Solid-state devices store large amounts of data, despite being very small.

Virtualization is when physical storage is pooled from multiple network storage devices into what seems to be one single storage device managed from a central console. Storage virtualization is usually used in a **storage area network (SAN)**, a network of storage devices that can be accessed by multiple computers. Many businesses use virtualization to consolidate many different servers onto one piece of physical hardware that then provides a simulated set of hardware to two or more operating systems. While cloud computing and virtualization are two distinct storage options, many cloud computing providers use virtualization in their data centers.

New Magnetic Media In the future, by manipulating molecules and atoms, magnetic hard drives will store as much as 1 terabyte (TB) per square inch of disk space. That's an increase of 100 times the 10 gigabytes per square inch of current hard drives.

New Optical Media DMDs, or digital multilayer discs, contain multiple layers of a fluorescent material that stores information on each layer. A disc can hold 1 terabyte of data.

Holographic Media A **holographic data storage system**, or **HDSS**, stores data in images called holograms on optical cubes the size of a sugar cube. These devices will hold more than 1 terabyte of storage and will be ten times faster than today's hard drives.

Technology @ Work

As more businesses use computers at work, the need for faster, more reliable, higher capacity storage devices is also on the rise.

Think About It!

Some businesses are storage-intensive while others require only basic components. The businesses listed below might benefit from a variety of storage technologies. Which would benefit more from new magnetic media? Which from DMD? Which from HDSS?

- graphic-design company
- school district
- online catalog
- hospital
- airline

Spotlight on...

MARVIN THEIMER

After a major earthquake hit California in 1989, many file storage systems were not working, and even backup data had been destroyed. It was then that Marvin Theimer started thinking about creating a disaster-tolerant storage system.

As a result, Theimer has been developing Farsite, a system which will let people back up their data on a system of networked computers. The exciting news about Farsite is that it uses the additional hard drive space that machines aren't using. That way,

even if 99 out of 100 machines in the network are destroyed, people will still be able to retrieve their information from the machine that is still working.

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

1. storage media
2. platter
3. write
4. read/write head
5. access time
6. USB flash drive
7. SSD
8. data transfer rate
9. laser sensor
10. pit

a. amount of time it takes storage device to begin reading data
b. one of the disks in a hard drive
c. removable, portable storage device inserted into a USB slot
d. save information on a storage medium
e. indentation on optical disc that does not reflect light
f. a mass storage device, similar to a hard disk drive that uses flash memory
g. needle-like device that retrieves and stores data on a magnetic disk
h. tool in optical drive that reads information
i. number of bits per second at which data is moved from a storage device to RAM
j. material that retains stored information saved by a computer storage device

Check Your Comprehension

Directions: *Determine the correct choice for each of the following.*

1. What type of media are used in a computer hard drive?
   a. magnetic
   b. optical
   c. solid state
   d. photo
2. What does the performance of a hard drive affect?
   a. if a read/write head can store data
   b. where a read/write head stores data
   c. how fast a computer reads and writes data
   d. the computer's memory
3. Which medium stores the least amount of information?
   a. DVD
   b. CD
   c. hard drive
   d. USB flash drive
4. Optical drives read information by using a _____.
   a. memory chip
   b. magnetic sensor
   c. laser sensor
   d. binary code
5. How many layers of material make up an optical disc?
   a. one
   b. two
   c. three
   d. four
6. Which of the following storage devices allow you to write data to a medium multiple times?
   a. CD-Rs
   b. read/write storage devices
   c. DVD-ROMs
   d. laserdiscs

Think Critically

Directions: *Answer the following questions.*

1. Why are disks (and discs) considered secondary—and not primary—storage devices?

2. Why is it important to be sure data is protected and secure? Give an example of how you can keep your data safe.

3. What can happen if a read/write head is disturbed?

4. How are magnetic storage devices organized?

5. If USB flash drives and CD-Rs cost about the same per megabyte of storage, which do you think is more advantageous? Why?

Extend Your Knowledge

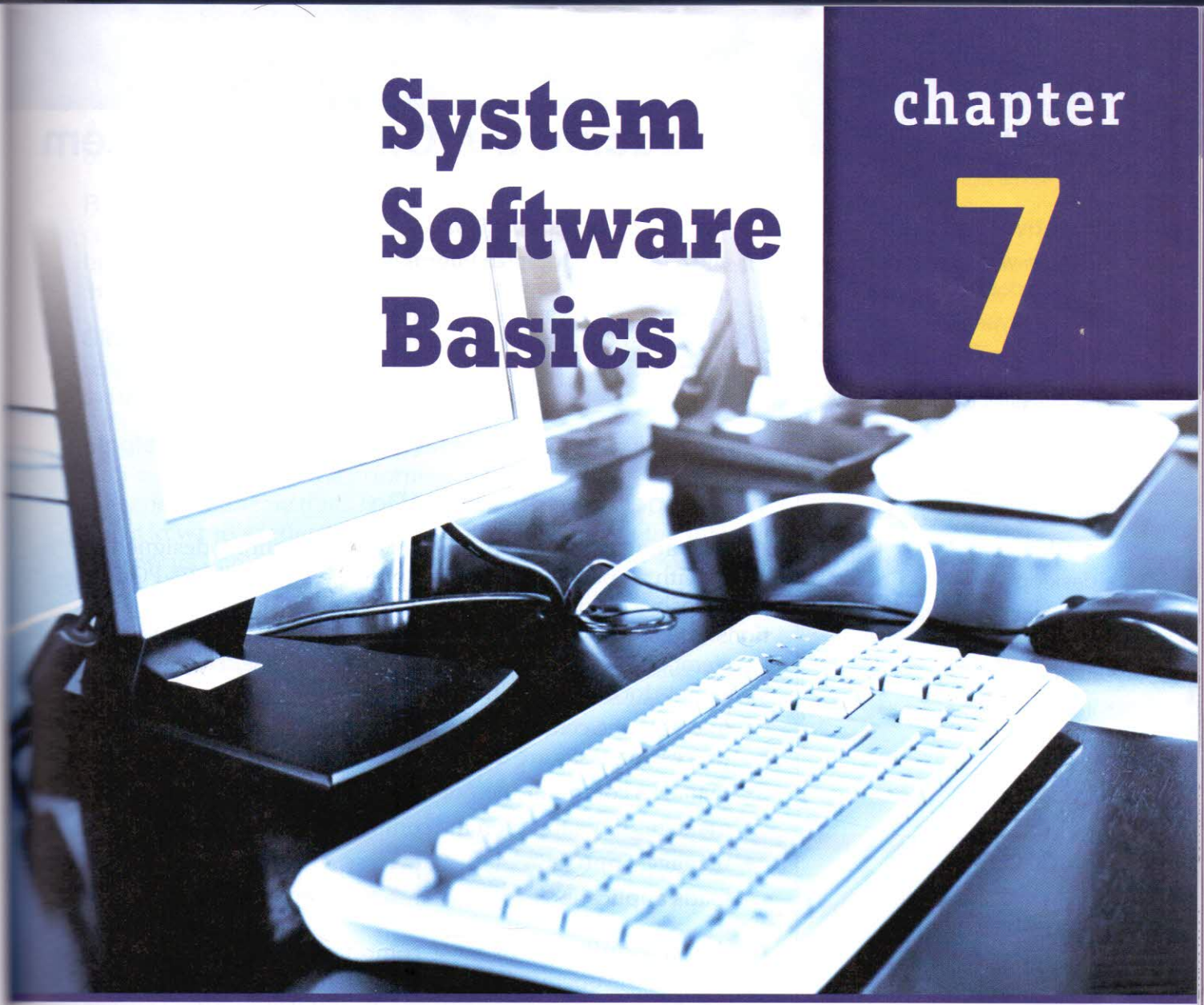
Directions: *Choose and complete one of the following projects.*

A. Find out the age and the storage capacity of the hard drive on the computer you use at school. By using computer ads or visiting a local retailer, find out what improvements have been made to hard drives currently on sale. What conclusions can you draw about today's computers?

B. Research evolving and emerging storage technologies. Take notes and keep track of your sources. What kinds of storage devices do you think computers will have in five to ten years? What trends, if any, do you predict? Present an oral report on the topic to your class.

chapter 7

System Software Basics



What Is an Operating System? Have you ever wondered what happens when you turn on your computer? For many users, just seeing that the computer starts and that they can begin working is enough to meet their needs. But to become a more knowledgeable user, you should know how your computer works. One of the main behind-the-scenes contributors is the operating system.

The operating system is like the control center of your computer: it controls everything that happens with your computer. The operating system makes sure that files are stored properly on storage devices, software programs run properly, and instructions to peripherals are sent, among other jobs. Without an operating system, your computer would not be able to perform even basic tasks.

Chapter Outline

Lesson 7–1

Introducing the Operating System

Lesson 7–2

Operating Systems and Utilities

Lesson 7–1 Introducing the Operating System

Objectives

- Explain what an operating system is and what it does.
- Identify types of operating systems.
- Describe a graphical user interface.

As You Read

Organize Information Use a concept web to help you collect information about operating systems as you read.

Key Terms

- crash
- desktop
- graphical user interface (GUI)
- icon
- interface
- update
- upgrade

What Operating Systems Do

An operating system (OS) is a set of instructions designed to work with a specific type of computer, such as a Dell® PC or a Macintosh® computer. The OS controls all the computer's functions. It also provides an **interface**, the on-screen tools you use to interact with the computer and your programs. The operating system performs several tasks:

- manages the central processing unit (CPU) so that processing tasks are done properly
- manages computer memory
- manages files stored on the computer's disks
- manages input and output devices
- loads application programs into memory

Avoiding Conflicts In most computers, especially personal computers, the operating system is stored on the hard drive. Before you can use the computer, a portion of the operating system must be loaded into memory. This is true of all programs; they may permanently reside on a disk but must be copied into RAM before you can use them.

Some operating systems enable a computer run more than one program at a time. To do this, the operating system has to assign each program some space in RAM, and then protect that space. Otherwise, conflicts can occur when two programs try to occupy the same space in RAM. When this happens, one or both of the programs may **crash**, or stop working, until the conflict is resolved.

Updates and Upgrades When companies that develop operating system software make improvements, they release new versions. A minor **update** fixes problems such as bugs, security issues, and the ability to work with new hardware and is usually delivered for free automatically over the Internet. A major **upgrade** introduces new features. Users wishing to upgrade purchase the software.

Types of Operating Systems

All computers require an operating system. There are four kinds of operating systems.

Real-Time Systems Real-time operating systems are used to control large equipment, such as heavy machinery and scientific instruments, and to regulate factory operations. In order for these systems to run, they require very little user interaction.

Single-User/Single-Task Systems This kind of system lets one person do one task at a time. An example is the operating system that controls a handheld computer.

Single-User/Multitasking Systems A multitasking system allows the computer to perform several jobs, either one after the other or at the same time. For example, you could use your computer to write a letter as it downloads a page from the Internet and prints another letter. Most desktop and laptop computers today use this kind of system. Windows and the Macintosh OS are examples of this type of operating system.

Multi-User Systems These systems allow many individuals to use one large computer. The OS balances all the tasks that the various users ask the computer to do. UNIX® is an example of this type of operating system.

Did You Know?

If a printer or other device fails to respond to a request from the operating system, there is probably a problem with the connection, such as a loose cable or disabled network connection. If you try to print a document and nothing happens, check that the cables are correctly and firmly attached, the device is plugged in, and that the network is operating correctly. For a printer, of course, you should also check that there is paper in the paper feeder.

Real-World Tech

An Operating System—in Your Dog? Robots are devices that can move and react to input from sight, hearing, touch, and balance. How are those "senses" and those reactions controlled? Through an operating system, of course! Robots are used to explore outer space and to do factory jobs. Now, however, they're also available as pets. Some robotic "dogs" can learn their own name and your name. They can show joy, anger, and surprise through lights, sounds, and gestures.

For what purposes do you think robots would be useful or fun?

Technology @ School

Fingerprint identification programs allow scanned fingerprints to be matched to electronic fingerprints stored in the computer.

Think About It!

For which activities below do you believe such a fingerprint identification system would be an advantage at school?

- paying for a school lunch
- checking out a library book
- taking attendance
- turning in homework
- accessing computer files

Operating Systems for Mobile Devices

Mobile devices such as smart phones and tablets are computers and therefore need an operating system to run properly. However, they cannot just use a PC's operating system, like Windows or Linux. Mobile operating systems have been designed to maximize the efficiency of a smaller touch screen, limited memory, and limited storage capacity. They are optimized to use wireless networks and to provide access to the specific apps most people expect from their mobile devices. Smart phones actually contain two operating systems: one that supports the user's software and one that operates the phone's hardware. Three common mobile device operating systems are Apple's iOS, Microsoft's Windows Phone, and Google's Android.

The User Interface

The operating system's user interface lets you start programs, manage disks and files, and shut down the computer safely. To start the OS, you turn the computer on. During the startup procedure, the OS places part of itself into the computer's memory.

Desktop Nowadays, computer operating systems are based on visual displays. The **graphical user interface**, or **GUI** (*GOO-ee*), lets you use a pointing device to interact with the workspace on the computer screen, called a **desktop**.

Icons On the screen, pictures called **icons** or tiles represent resources on the computer such as a program, a document, a hardware device, or a Web site. You click or double-click an icon or tile to perform an action, such as starting a program or opening a file.

Options You can use the operating system to customize some features of the desktop, such as the look of the background or the placement of the icons. You can also change how other components work, such as keyboard functions and the speed at which the cursor blinks on the screen. Use the documentation that came with your system or the Help program to explore these options.

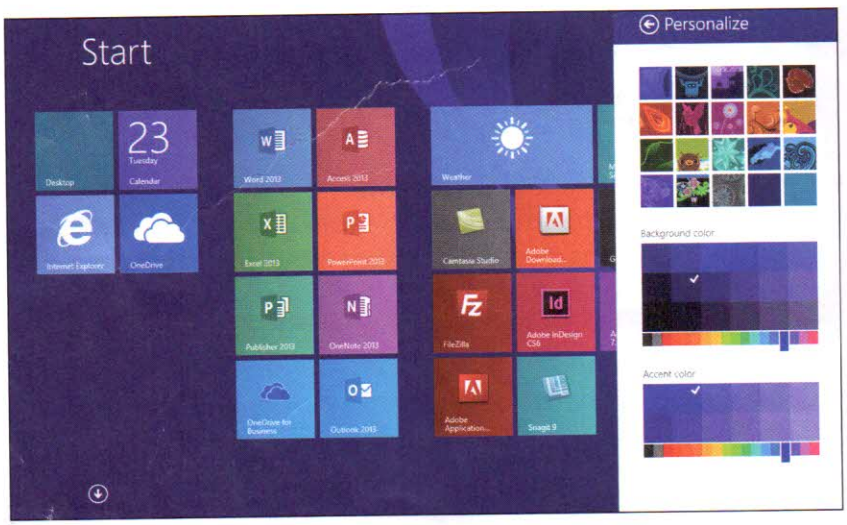


Figure 7.1.1 Options for personalizing the Windows 8 Start Screen.

Operating Systems and Utilities

Lesson 7–2

Objectives

- Examine different operating systems.
- Discuss the function of the file manager in an operating system.
- Describe how system utilities help operating systems function.

As You Read

Outline Information Use an outline to help you note details about operating systems and system utilities as you read.

Popular Operating Systems

The first widely-used operating system for personal computers was called MS-DOS. It was developed in the early 1980s by Microsoft for IBM-compatible PCs. Now, three operating systems dominate the computer world—Microsoft Windows®, the Macintosh OS, and UNIX. The computer you use at school or at home probably has a version of Windows or the Macintosh OS installed. UNIX, and adaptations of it, is most often found running on large business or scientific networks.

Mac OS X® In 1984, Apple® became the first computer maker to sell consumers a personal computer equipped with a graphical user interface (GUI). *Macintosh* names both the computer and its operating system. Easy for beginners to use, some version of the Mac OS runs all Macintosh computers.

Microsoft Windows Although Microsoft Windows was not the first OS to have a GUI, the Windows OS is currently the market leader, installed on more than 90 percent of personal computers. Early versions of Windows were based on MS-DOS. In fact, Windows 98 was the last version of Windows based on MS-DOS.

UNIX and Linux™ UNIX was one of the first operating systems ever written. It was designed to work on powerful business and scientific computers. Later versions of UNIX have been developed to work on personal computers.

One of these versions of UNIX is a system called Linux. Linux works with an optional GUI and is very fast compared to other operating systems. It is also unique in that it is an open-source operating system, in which the source code used to create it is available to the public. Programmers from across the globe constantly work on Linux to test and improve it. Linux is free and can be downloaded from the Internet, but most users buy it with other features. Though Apple and Microsoft dominate the market of OS for personal computers, Linux is now challenging them for a share of the web client OS market.

Key Terms

- backup utility
- driver utility
- file compression utility
- install
- Plug and Play (PnP)
- reinstall
- uninstall
- versioning

Technology @ Home

GUI designers choose icons that most people recognize.

Think About It!

Which items below are represented by an icon on a home computer?

- music files
- e-mail
- Internet browser
- printer
- text files
- antivirus software

System Utilities: File Management

Utility software is a collection of programs that help you maintain and repair your computer. Today, many types of utilities are built into the operating system. Probably the most important utilities are file managers, which let you work with data stored on your computer.

Organizing Files The operating system, programs, and data are all stored in files, each with a name. Files can be grouped together into folders. Folders are also called directories. A folder can be divided into subfolders.

Using Files You can use an operating system's file manager to perform several tasks:

- create new folders or subfolders
- move or copy items between folders or to other disks
- delete files and folders
- launch applications

Finding Files You can use the file finder utility from your operating system to help you look for a file. This utility can search for a file by its name, type, date, or even by looking for specific data inside the file.

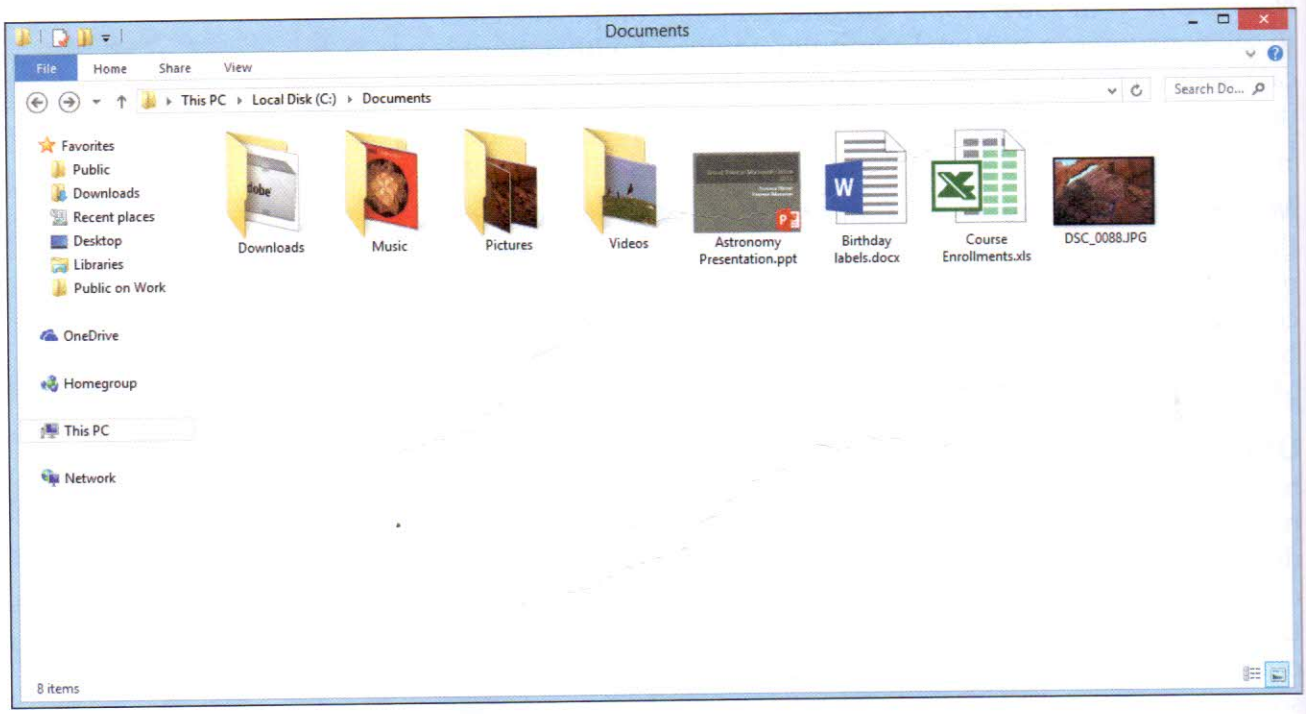


Figure 7.2.1 Use an operating system such as Windows to organize and manage files and folders.

System Utilities: Other Jobs

Your operating system probably has utilities that can help with routine maintenance and other jobs.

Driver Utilities A **driver utility** contains data needed by programs to operate input and output devices such as a mouse and printer. Operating systems that have **Plug and Play (PnP)** capability can automatically detect new PnP-compatible devices. Otherwise, you can download the files from the device manufacturer's Web site, or use the installation CD/DVD.

Program Utilities Before you can use a program, you must **install** it on your hard drive. In Windows, you can use the Add/Remove Programs utility to ensure that your program installs properly. You can use the same utility to **uninstall**, or remove, a program you no longer need, or to **reinstall** a program that is not working the way you want.

Backup Utilities **Backup utility** programs automatically copy data from the computer's hard drive to a backup storage device, such as an external hard drive or a CD. Businesses and individuals routinely use backup utilities to ensure data is not lost if a computer or disk drive fails. You, too, should regularly back up your computer data. By maintaining a regular back up schedule, and by keeping incremental versions of backed up files, you minimize the risk of losing data. Some operating systems, including Windows and Mac OS, have **versioning**, which automatically saves previous versions of files that you change. This is another way of avoiding data loss.

File Compression Utilities **File compression utilities** are programs that reduce the size of files without harming the data. These programs make it easier to copy and send files.

Global Settings Operating systems also manage global settings for features such as privacy and storage. For example, global settings may be used to control access from outside sources, such as whether an online game can store a score on your computer.

Connections

Science If your science teachers have not yet done so, they may soon add to your computer a microscope and a driver to control it. Computer microscopes allow an enlarged image to appear on the monitor or on a wall screen, making it easier for groups to see. Students can also capture images to study and use in reports and presentations.

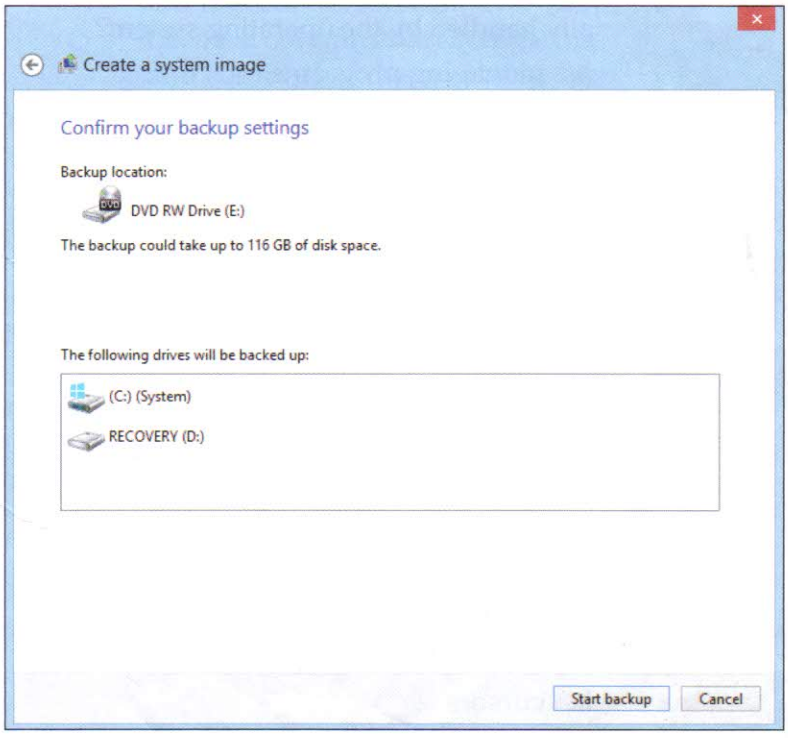


Figure 7.2.2 Microsoft Windows comes with utilities for backing up and restoring data and programs.

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

1. interface
2. crash
3. graphical user interface
4. desktop
5. icon
6. driver utility
7. Plug and Play
8. backup utility
9. file compression utility

a. area on a computer screen where you perform work

b. to stop working

c. program that controls input/output devices

d. picture that represents something on a computer

e. on-screen tools that let you use the computer

f. program that copies a file onto another medium

g. lets you use a mouse to work with the computer

h. capable of detecting compatible devices

i. reduces file size without harming data

Check Your Comprehension

Directions: *Determine the correct choice for each of the following.*

1. Which of the following is NOT usually handled by the operating system?
   - **a.** managing programs
   - **b.** dealing with input/output devices
   - **c.** publishing Web pages
   - **d.** interacting with the user
2. Which kind of computer operating system usually requires the least amount of user interaction?
   - **a.** real-time systems
   - **b.** single-user/single-task systems
   - **c.** single-user/multitask systems
   - **d.** multi-user systems
3. Which of the following is a key part of a graphical user interface?
   - **a.** command words
   - **b.** cursors
   - **c.** memory
   - **d.** icons
4. Which operating system is found most often on large business and scientific computers?
   - **a.** Microsoft Windows
   - **b.** Mac OS
   - **c.** UNIX
   - **d.** Linux
5. Which of the following do operating systems, application programs, and user data have in common?
   - **a.** They are all system utilities.
   - **b.** They are all Windows-based.
   - **c.** They are all created by the user.
   - **d.** They are all stored in files.
6. What kind of utility is used to reduce the size of a file?
   - **a.** driver utility
   - **b.** program utility
   - **c.** backup utility
   - **d.** file compression utility

Think Critically

Directions: *Answer the following questions.*

1. What are the major functions of an operating system?

2. What effect do you think the development of graphical user interfaces had on the number of people using computers? Why?

3. Pick one operating system component such as disk operations, GUI, or hardware drivers and explain its purpose.

4. Why might you install an operating system update?

5. Why is it a good idea to back up your important files?

Extend Your Knowledge

Directions: *Choose and complete one of the following projects.*

A. Go to Help in a Microsoft Windows operating system. Find out how it is organized, but make no changes to the system settings. Follow the same process on a Macintosh computer. Which Help section was easier to use? Provide reasons for your preference. Discuss your conclusions as a class.

B. Find ads in computer magazines or on the Web that are sponsored by companies that sell backup and file compression utilities. Make a chart to summarize the features of three products in each category. Note which operating system each product works with and its price. Create a word-processing document in which you summarize your findings. Name and save the document using proper file management techniques. With your teacher's permission, print the document. Read it out loud with a partner or to the class.

C. With your teacher's permission, use the Internet to research two or three operating systems for mobile devices. As you work, take notes and keep track of your sources. Evaluate the information you find and only use it if it is accurate, relevant, and valid. Create a column chart comparing and contrasting the operating systems. Share the chart with a partner or with the class.

Understanding System Software

chapter 8

What Is the Purpose of an Operating System? When you use a computer program, most of the activity you see on the screen is conducted by the operating system. An application, such as a word processor, asks the operating system to perform actions, such as opening a file, printing a document, or showing a list of recently used documents.

To fulfill these requests, the operating system needs to know how to handle different **file formats**, or standards used to save data on a disk. Those formats determine how text documents, graphics, audio, and video files are stored and used. In this chapter, you will learn more about what the functions that the operating system and its utilities perform, and how you use them.

Chapter Outline

Lesson 8–1

Exploring the Operating System

Lesson 8–2

Exploring System Utilities

Lesson 8–1 Exploring the Operating System

Objectives

- Summarize the boot process.
- Describe the features of a graphical user interface.
- Explain how operating systems can be configured and changed.

As You Read

Organize Information Use a concept web to help you collect information about operating systems as you read.

Key Terms

- boot
- CMOS
- hibernate mode
- pop-up menu
- power-on self test (POST)
- pull-down menu
- Ribbon
- screen saver
- sleep mode
- system administrator
- user account
- user rights
- window

Loading the Operating System

The operating system, or OS, controls the computer and manages its work. The OS also provides an interface which enables you to interact with the computer.

The Boot Process When you turn the computer on, you **boot** it. That is, you start the computer, and it responds by loading the operating system. If your computer is set to show it, the first thing you see is the BIOS screen. As you learned earlier, *BIOS* stands for basic input/output system, and it manages and configures the computer's hardware. This means that the computer will be able to accept input from the keyboard and display information.

The Power-On Self Test As a computer boots, it performs a series of tests called the **power-on self test**, or **POST**. During POST, the BIOS or UEFI checks the major components of the system, such as its memory, keyboard, and hard drive. It does this in part by reading information stored on the **CMOS** chip. CMOS, which stands for Complementary Metal-Oxide Semiconductor, is a battery-powered memory chip on the motherboard that stores information about the computer components.

If there is a problem during start up, a written message or a sound alerts you. If this happens, the computer may need repair. If no problem is detected, parts of the operating system are loaded from storage into memory and take control of the computer.

The Login As the operating system starts, you may see a screen that asks you for a username and password. This is called the login screen. Businesses and schools often use this process to control who has access to the computer.

Exploring the GUI

When the operating system is loaded into RAM, it displays the desktop provided by the graphical user interface, or GUI. The desktop is where all work is done, including opening and clos-

ing programs, modifying system settings, and managing files. Icons on the desktop allow you to launch programs by clicking or double-clicking them. You also can click Start (on a PC) or Finder (on a Macintosh®) and then the name of the program you want. A taskbar on the desktop identifies which programs or files are open. To switch back and forth among applications, just click what you want to work on next.

Using Windows The operating system in today's PCs and Macintosh computers displays documents in **windows**, or rectangular, on-screen frames that can be opened, closed, resized, and rearranged to view programs or documents. Each window provides commands and options. Some programs have **pull-down menus** that list commands when you select an item from the menu. Sometimes menus have submenus with additional commands. In Microsoft Office, the window provides commands on the **Ribbon**, a series of tabs at the top of the window. Each tab has a group of related commands for specific tasks. A command may display a dialog box that lets you set several options at the same time.

Pop-up menus, or lists of shortcut commands that appear when an area of the screen is clicked or right-clicked or the mouse button is held down, can appear anywhere in a window. Pop-up menus can be context-sensitive, providing options that relate to tasks you are doing at that moment.

Did You Know?

Today, a number of operating systems use voice recognition, which allows you to say, for example, "Computer, start word processing," or "Computer, check e-mail," and the computer will know what you mean. However, you must know the right commands. If you say, "Ditch that file," instead of "Delete that file," the computer will not know how to process the command.

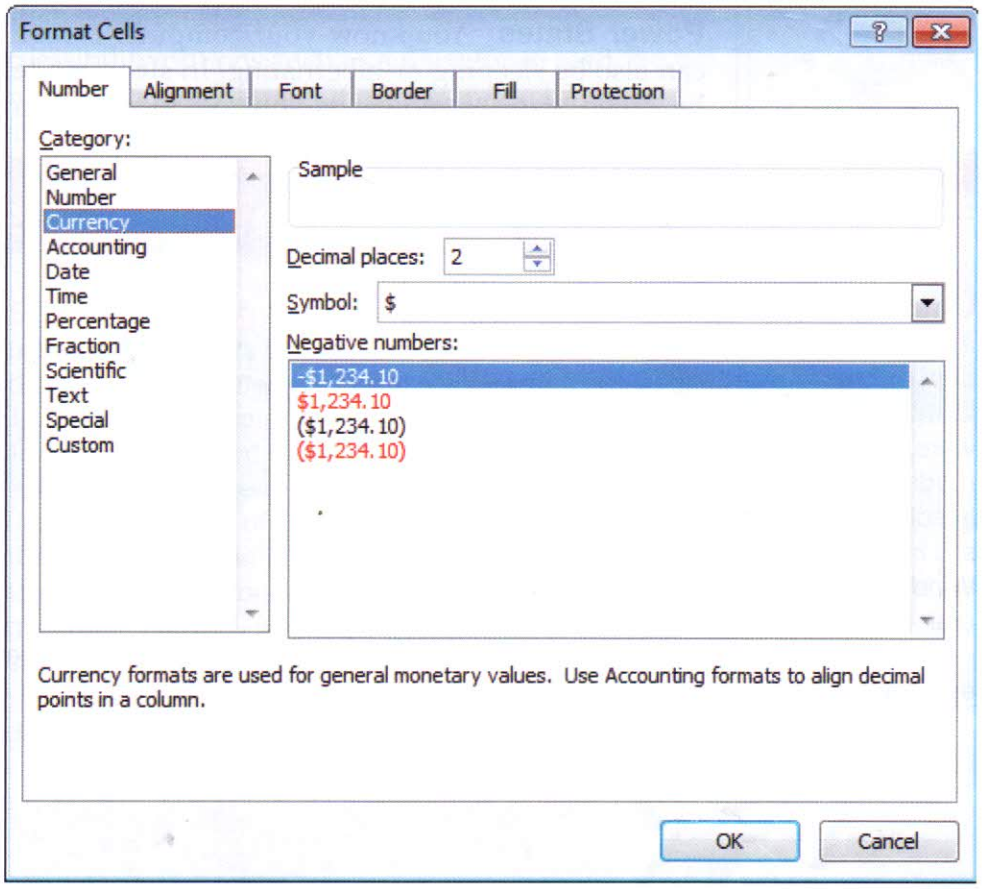


Figure 8.1.1 Many programs have dialog boxes you use to select options, such as number formats in a spreadsheet.

Connections

The Arts CRT monitors can be damaged if the same image stays on the monitor for an extended period of time. A screen saver is a utility designed to protect the monitor by continuously changing the image it displays. Most screen savers use an animated effect, such as flying graphics or product logos, or imaginative shapes that build themselves piece by piece on the screen. On LCD monitors, screen savers are used for fun instead of for protection.

Screen savers are created by talented artists, using sophisticated digital drawing and animation tools. These artists need to know more than just how to draw; they need to know how to create effective, small-scale animations that will work under a specific operating system.

Exploring Configuration Options

Computer systems come in many different configurations. In order for an operating system to work correctly on every computer it must be flexible. The two most common tools an operating system uses to adapt to different requirements are drivers and system preferences.

- Drivers let the OS work with different devices and peripherals. Some basic drivers for common devices such as a keyboard and a mouse are built into the operating system. Other drivers you install when you connect a device.
- System preferences let the user select options for controlling and customizing options, such as the appearance of the user interface or how the computer will shut down. In Windows, you use the Control Panel to access the customization options. On a Mac, you use the System Preferences command.

Power Options You can usually set options to control the way a computer uses power. This is particularly important when you use a system such as a tablet or notebook that relies on a battery. Using more power might increase performance, but it also drains the battery faster and costs more on your energy bill. Some operating systems, such as Windows, have built-in power plans designed for maximum performance, maximum energy conservation, or a balance.

Power States You know your computer can be on or off. It can also be sleeping or hibernating. In **sleep mode**, which may be called standby, power is shut off to non-essential compo-

Real-World Tech

Offering a Free Operating System

As discussed, the operating system Linux® is based on a powerful scientific system called UNIX®. Linux is freeware, or open-source software, which means programmers can freely modify its code. To help expand computer use in schools in Mexico, Miguel de Icaza, while still in his 20s, developed GNOME, one of the Windows-based, easy-to-use desktop graphical user interfaces for Linux.

What are some of the advantages and disadvantages of a freeware operating system?

nents. Some power is used and data remains in RAM. In **hibernate mode**, data from RAM is saved to the hard disk and then power is shut down.

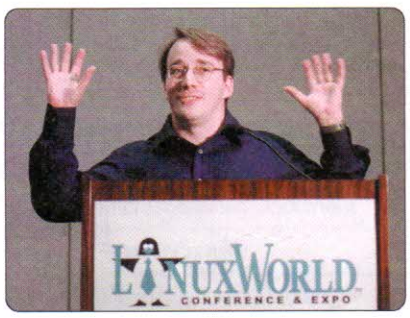
Most operating systems let you select options for entering sleep mode or powering down the display after a set period of inactivity. On a tablet or notebook, you might also be able to change the function of the Power button. Options include doing nothing, powering down, sleeping, or hibernating. Some operating systems automatically lock the system after a set period of inactivity. You must enter a password or PIN number to unlock the system to regain access.

Changing system settings lets you customize your computer, but it can also cause your computer to malfunction. Most operating systems have a feature that lets you restore settings to a previous configuration.

Desktop Changes Your operating system lets you change the desktop display. Among your choices are these:

- change the background appearance of the desktop, sometimes called the wallpaper
- change the **screen saver**, a utility program that changes the screen display after a preset period of nonuse
- add or eliminate desktop icons for various programs
- display or hide the taskbar
- change the language used to display menus, Help, and other system communication
- enable accessibility options such as a narrator to read screen text out loud and a magnifier to increase the size of content on the screen

Real-World Tech



See It on the Big Screen One fascinating task that computers do is create some of those dramatic special effects you see in movies. The Linux operating system, authored by Linus Torvalds (pictured at right), has been especially influential in this area in recent years. Linux was used in the filming of *Titanic* to make a model of the ship look real; in *The Fellowship of the Ring* to make human actors look small and a computer-generated troll look huge; and in *Shrek* to combine models and animation with startlingly lifelike effects.

What movie have you seen recently in which the special effects caught your attention?

Connections

Social Studies Adding new hardware to a classroom computer can create exciting possibilities. Think of a user account for a social studies teacher on a school district's network. If the hardware rights for the account allow the user to add hardware, the teacher might connect a large-screen monitor so a current event article downloaded from a history Web site could be displayed for the entire class to read at once. A map downloaded from the Internet could also be displayed on the monitor.

With installation rights, Webcams, and a microphone, students could interview a political figure or complete a project with students in another city.

Managing User Accounts

Since computers are used for many different tasks, from playing games to writing reports and calculating numbers, businesses may want to restrict the use of some programs and files to designated users. This may also be true in schools, homes, and other settings where several people can use the same computer.

Usernames and Passwords One way to protect data is to set up **user accounts** that identify who can access a computer. Each user is assigned a username and a password that he or she must provide in order to gain access. User accounts are set up using a system tool provided by the operating system. The **system administrator** is the person responsible for maintaining the computer system and for setting up user accounts. He or she has permission to customize and configure all aspects of the system for all users.

User Rights User accounts may also have specific **user rights** assigned to them to limit or allow access, including:

- file access rights that specify which files a user can access and whether he or she can only read files or has access to read and write (edit) them
- installation rights that specify whether a user can install or remove programs
- hardware rights that specify whether a user can add or remove hardware
- configuration rights that specify whether a user can change operating system settings
- group policy rights that specify configuration and policy settings for a group of users on computers and mobile devices

Logging On and Off To access your account, you log on to the system. When you are finished, you should always log off so no one else can access your data and account information. Most operating systems also let you switch users without logging off. This closes your account and switches to the account for the other user.

Exploring System Utilities

Lesson 8–2

Objectives

- Analyze file names and file formats.
- Explain cross-platform compatibility issues.
- Identify and discuss system maintenance utilities.

As You Read

Draw Conclusions Use a chart to help you draw conclusions about system utilities as you read.

Managing Files and Folders

Among the most important system utilities is the file manager, called Explorer in Windows and Finder in Mac OS. This utility allows you to organize, view, copy, move, rename, and delete files. You can even use it to create certain types of files.

Directories and Folders Most operating systems manage file storage using a multilevel, or **hierarchical**, filing system called a **directory**. The directory looks like the roots of a tree. At the top is the main storage location, called the **root directory**. Within the root are **subdirectories** called folders, which may contain other folders, called subfolders, and files. You navigate through the hierarchy by expanding and collapsing the folders to show or hide their contents. Most operating systems come with some folders already set up. For example, Windows comes with Documents, Pictures, Control Panel, and so on. You can create new folders and subfolders as needed.

Naming Files and Folders When you create a new file or folder, you give it a **file name**. Using descriptive names helps you identify the contents and keep your data organized. For example, the name *2013 Annual Report* is more descriptive than *Report*. It also helps keep you from accidentally deleting or overwriting files and folders that have the same name. Most operating systems have specific file and folder naming conventions. They usually let you use file and folder names with up to 255 characters, including spaces and punctuation. You cannot use <. >/ :. ", /, \, |, ?, or *.

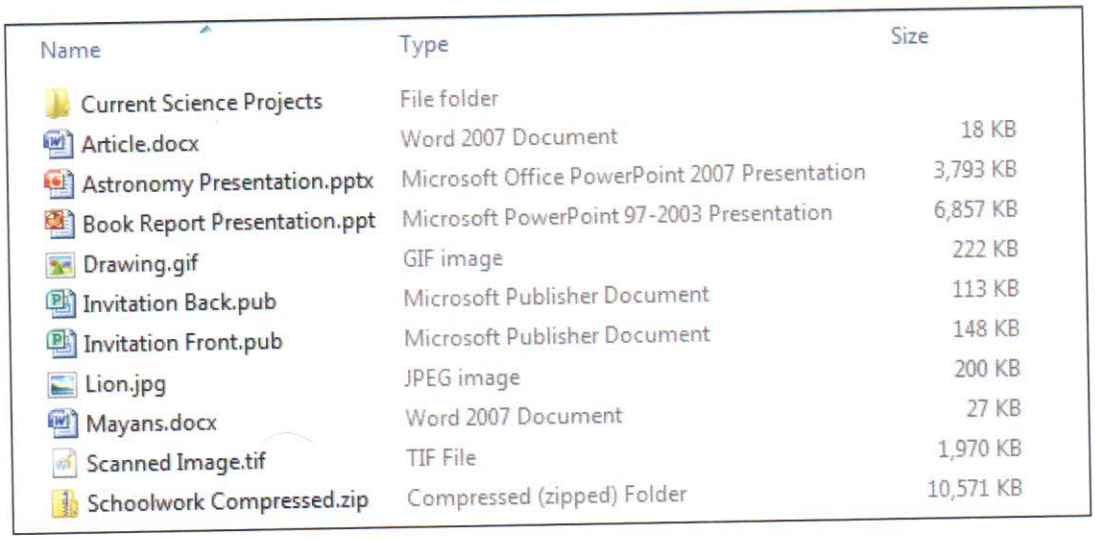
Key Terms

- corrupted
- cross-platform compatibility
- directory
- disk scanner
- file extension
- file format
- file fragmentation
- file name
- hierarchical
- malware
- root directory
- subdirectories
- virus

Common File Type Extensions

Extension	File Type
.doc/.docx	Microsoft Word Document
.txt	Text Document
.xls/.xlsx	Microsoft Excel Document
.ppt/.pptx	Microsoft PowerPoint Presentation
.wav	Waveform Audio File
.mp3	MP3 Audio File
.jpg	JPEG Image File
.mov	Quicktime Video File
.zip	Compressed File
.html	HTML File
.csv	Comma Separated Values Document

File Type Some operating systems, such as Windows, automatically add a period and a file extension to file names. A **file extension** is a short series of letters that indicate the application used to create the file and the **file format**. The file extension determines the file type. For example, a Microsoft Word document has the extension .doc or .docx. You can set options to display file types when you view a file list. By default, the operating system uses the program associated with the file type to open the file. So, a file with an .xlsx extension opens in Microsoft Excel and a file with a .wmv extension opens in Windows Media Player.



Name	Type	Size
Current Science Projects	File folder	
Article.docx	Word 2007 Document	18 KB
Astronomy Presentation.pptx	Microsoft Office PowerPoint 2007 Presentation	3,793 KB
Book Report Presentation.ppt	Microsoft PowerPoint 97-2003 Presentation	6,857 KB
Drawing.gif	GIF image	222 KB
Invitation Back.pub	Microsoft Publisher Document	113 KB
Invitation Front.pub	Microsoft Publisher Document	148 KB
Lion.jpg	JPEG image	200 KB
Mayans.docx	Word 2007 Document	27 KB
Scanned Image.tif	TIF File	1,970 KB
Schoolwork Compressed.zip	Compressed (zipped) Folder	10,571 KB

Figure 8.2.1 You can display file types when viewing files with Windows.

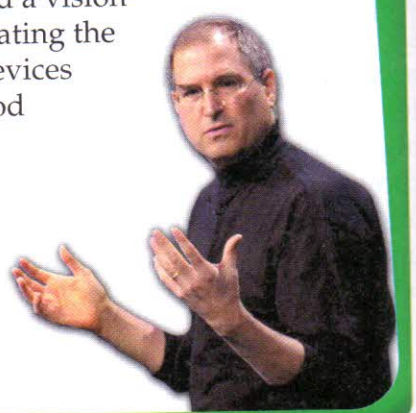
Spotlight on...

STEVE JOBS

"I know if I got run over by a bus tomorrow, Apple's going to keep on going—because the engines have been put in place and cultures have been put in place to keep innovating, to keep doing things at this level of quality."

Steven Jobs
Founder, Apple computers

At age 21, Steven Jobs and his friend Stephen Wozniak founded Apple Computer Company in the Jobs' family garage. A year later, Apple released the first mass-market personal computer. In 1984, Apple released the Macintosh computer, the first personal computer to use a GUI. Jobs, who passed away in 2011, was considered a visionary for anticipating the demand for devices such as the iPod music player, iPhone smart phone, and iPad tablet computer.



Using Files on Different Operating Systems

The two most widely used operating systems are Microsoft Windows on PCs and Mac OS on Apple Macintosh computers. Many times, a file created on one OS can work on another. This is because the OS associates files with specific programs.

Cross-Platform Compatibility Sharing files across operating systems is called **cross-platform compatibility**. There are two keys to compatibility. First, both operating systems must have the same program installed in a compatible version that has been written for each operating system. Second, the application must allow its file formats to be shared across different operating systems. There are some programs that allow you to run a second operating system on a computer. For example, Apple's Boot Camp allows Windows and Windows programs to run on a computer with Mac OS.

Using System Maintenance Utilities

Like any machine, a computer needs routine maintenance. System maintenance utilities do these jobs and more.

Disk Management Computer files can be **corrupted**, or damaged to the point at which data is unrecoverable, in different ways. One way is by being stored on a damaged part of the hard drive. Running a utility called a **disk scanner**, which checks magnetic disks for errors, can fix this problem. A disk scanner looks for and tries to correct irregularities on a disk's surface. You can use a disk cleaner utility to identify files such as cookies, offline Web pages, and temporary files that you can delete to make more disk space available.

Disk Defragmenter As you add, move, and delete files on your computer, parts of files end up saved in different areas of the hard drive. **File fragmentation** occurs when a file is broken into pieces that are saved in different places on a hard drive.

File fragmentation reduces disk efficiency because the read/write head must travel longer distances to retrieve parts of a file that are scattered across a disk than if the files were stored close together. A disk defragmentation program can gather all the file pieces and place them together, thus improving the efficiency of the disk or hard drive.

Emulation Developers To strengthen their appeal to users, operating system and application developers often create emulation hardware or software that allows an operating system designed for one hardware platform to work on another. To work as a developer in this field, candidates must have strong experience in hardware and software engineering.

Technology @ Home

A digital picture frame is a simple computer with a CPU, memory, and an operating system. It has an LCD screen that displays a slide show of photographs sent via the Internet.

Think About It!

Which system utilities listed below might you want to run when sending digital photos via the Internet?

- file manager
- disk scanner
- disk defragmenter
- antivirus software

Virus Detection Viruses and malware can enter your system through infected e-mail messages, programs, and files. **Malware** is any type of software designed to damage or disable your computer system or data. A **virus** is a type of malware that can replicate, or copy, itself. Antivirus and antimalware utilities constantly monitor your system for viruses and malware programs that can slow down processing or damage your data and devices. Once there, they can destroy or corrupt data.

Antivirus programs check your computer's memory and disks looking for virus code. Most programs can also check e-mail and files as they are downloaded to your computer from the Internet. If the program finds a virus, it alerts you and then attempts to disable and remove the virus.

Because new viruses and malware are introduced every day, it is important to install antivirus and antimalware program updates automatically whenever they become available.

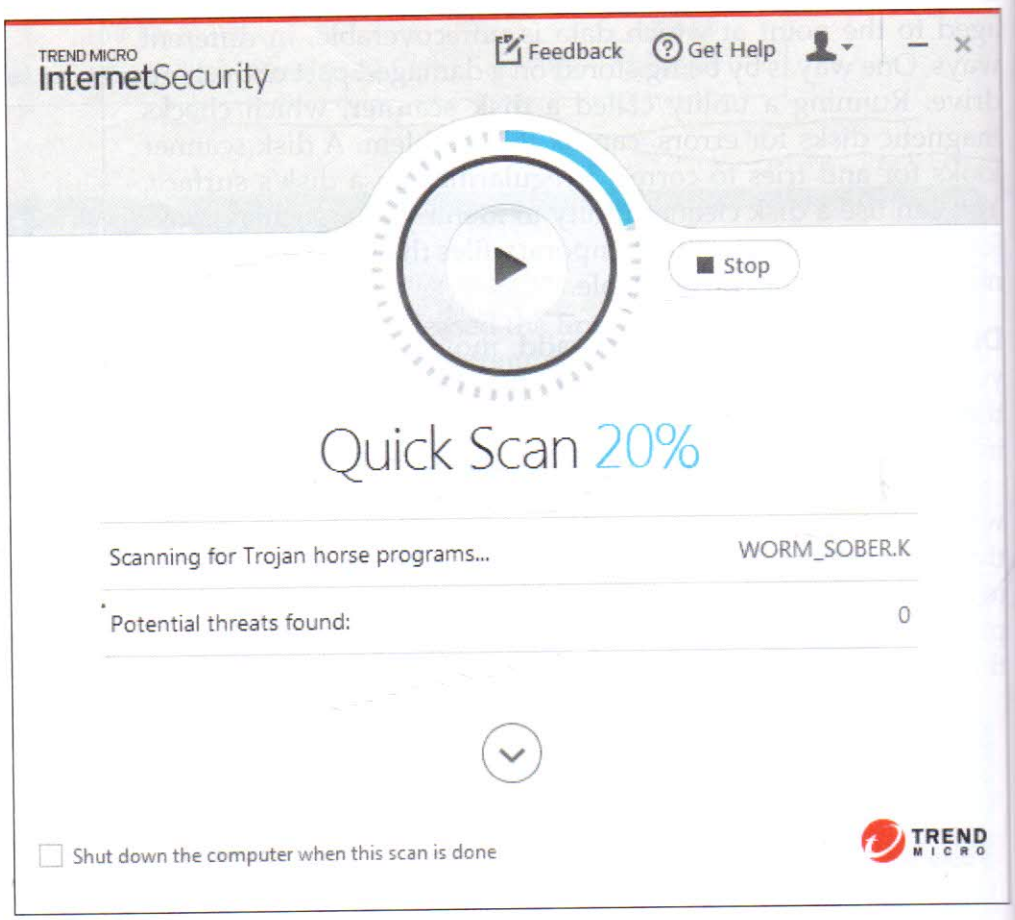


Figure 8.2.2
Using a virus protection program to scan for viruses.

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

A	1. boot	a. to start the computer and load the operating system
F	2. POST (Power on self-test)	b. option that appears when an item is selected from the menu bar
I	3. window	c. utility that looks for errors in magnetic media
B	4. pull-down menu	d. changes the display on the desktop
H	5. pop-up menu	e. two to four letters that identify a file's format
D	6. screen saver	f. series of tests run during the boot process
E	7. file extension	g. ability to share files across operating systems
G	8. cross-platform compatibility	h. shortcut command that appears anywhere in a window
C	9. disk scanner	i. frame that displays a document or file
J	10. file fragmentation	j. having parts of files stored on different areas of a disk or hard drive

Check Your Comprehension

Directions: *Determine the correct choice for each of the following.*

1. Which of the following indicates that the computer can accept input from the keyboard and display information on the monitor?
   - a. POST
   - b. BIOS screen
   - c. GUI
   - d. cross-platform application
2. At what point in the boot process can users be asked their username and password?
   - a. at the control panel
   - b. in a screen saver
   - c. in a file manager
   - d. at login
3. If a pop-up menu is context-sensitive, what is it related to?
   - a. file format
   - b. printer settings
   - c. what you are doing
   - d. operating system
4. Which of the following is NOT a system change most users should attempt?
   - a. moving the operating system
   - b. adding a scanner
   - c. changing mouse settings
   - d. removing a program
5. Along with the data itself, which of the following is saved with a file?
   - a. login procedure
   - b. code for the application that created it
   - c. icon that describes it
   - d. maintenance utility

   we have to clear
6. Which of the following is one way that a file can be corrupted?
   - a. by deleting it
   - b. by appearing on the desktop
   - c. by moving it to a new folder
   - d. by storing it on a damaged disk

Think Critically

Directions: *Answer the following questions.*

1. List at least one program that you run on a personal computer but wouldn't run on a mobile device?

2. What is a file type and why is it important? Give at least three examples of file types, including the associated file extension and program.

3. Why do most operating systems let users make system changes?

4. Suppose some of the reporters and photographers for your local newspaper work from home and are networked. What is an example of one application that would allow them to work without concern for the operating system they use?

5. What are system management tools and how are they used? Give an example.

Extend Your Knowledge

Directions: *Choose and complete one of the following projects.*

A. With a partner, interview three adult computer users: one who uses Microsoft Windows, one who uses a Macintosh, and one who has experience with both operating systems. Prepare written questions related to ease of learning the operating system, ease of use, availability of programs, and overall satisfaction with the operating system, and take notes to record the answers. Add your findings to your own experiences and write a conclusion about the user preferences of the two major operating systems. Share your conclusion with a partner or with your class.

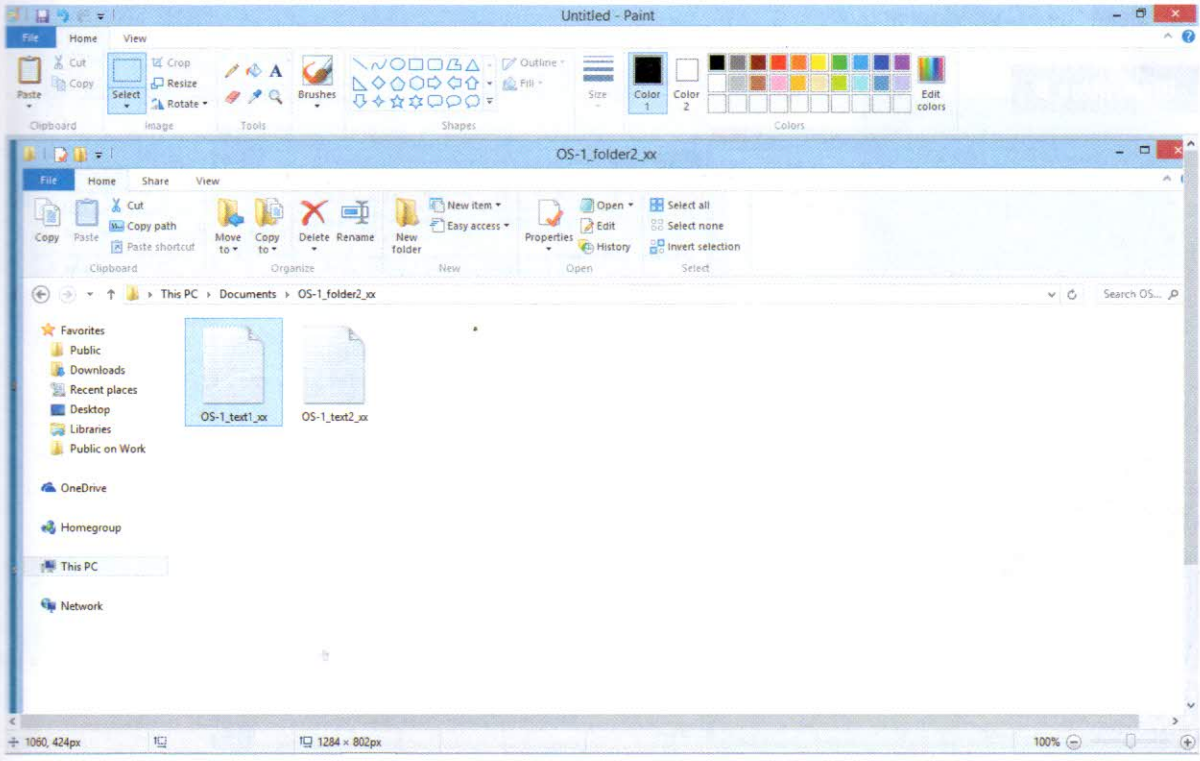
B. Explore the desktop on your computer. Identify the icons on the desktop and explain what each launches. Use the taskbar to identify files or programs that are open and the file formats they are in. How does the desktop help you manage your work on the computer? Using a text editor, word-processing application, or on paper, write a paragraph explaining the concept of a computer desktop. Then, write step-by-step instructions that someone could use to arrange items on the desktop. With your teacher's permission, print or publish the document and exchange it with a classmate. Read your classmate's work. As a class, discuss why step-by-step instructions are useful.

Operating System Activity 1: Managing Files and Folders

DIRECTIONS: *You will use your operating system to navigate to a storage location where you will create a folder. You will then create, copy, move, rename, and delete files and subfolders. You will also display file properties and change the folder view.*

1. Start your computer, and log in to your user account, if necessary.
2. Use your operating system to navigate to the location where your teacher instructs you to store the files for this activity. For example, plug a flash drive in to a USB port, and display the contents of that drive in a program window.
3. In the storage location, create a new folder named **OS-1_folder1_*xx***. Replace ***xx*** with your own initials or name, as directed by your teacher.
4. In the same storage location, create a new text document named **OS-1_text1_*xx***.
5. Copy **OS-1_text1_*xx*** in to **OS-1_folder1_*xx***.
6. In **OS-1_folder1_*xx***, rename **OS-1_text1_*xx*** to **OS-1_text2_*xx***.
7. Navigate back to the original storage location.
8. Rename **OS-1_folder1_*xx*** to **OS-1_folder2_*xx***.
9. Move **OS-1_text1_*xx*** in to **OS-1_folder2_*xx***.
10. Open **OS-1_folder2_*xx*** and, if not already selected, change the folder view to Large Icons.
11. Maximize the folder window, and then, on your keyboard, press the key combination to capture an image of the folder window on the screen. For example, press ALT + PRTSC .
12. Start a graphics or paint program, such as Paint, and paste the screen capture image in the program window. It should look similar to Illustration A.
13. Save the file in the default graphics file format as **OS-1_image1_*xx*** in **OS-1_folder2_*xx***.
14. With your teacher's permission, print the file, and then exit the program.
15. In **OS-1_folder2_*xx*** , change the folder view to Content.
16. Change the folder view to Details.
17. Display the properties for **OS-1_image1_*xx***, and then close the Properties dialog box.
18. Delete **OS-1_text2_*xx***.
19. In **OS-1_folder2_*xx***, create a new folder named **OS-1_folder3_*xx***.
20. Copy **OS-1_text1_*xx*** into **OS-1_folder3_*xx***.
21. With your teacher's permission, make a backup copy of **OS-1_folder3_*xx*** and then delete the folder.
22. Navigate to the original storage location, and close it.
23. If necessary, safely remove or eject the storage device.
24. With your teacher's permission, log off and/or shut down the computer.

Illustration A

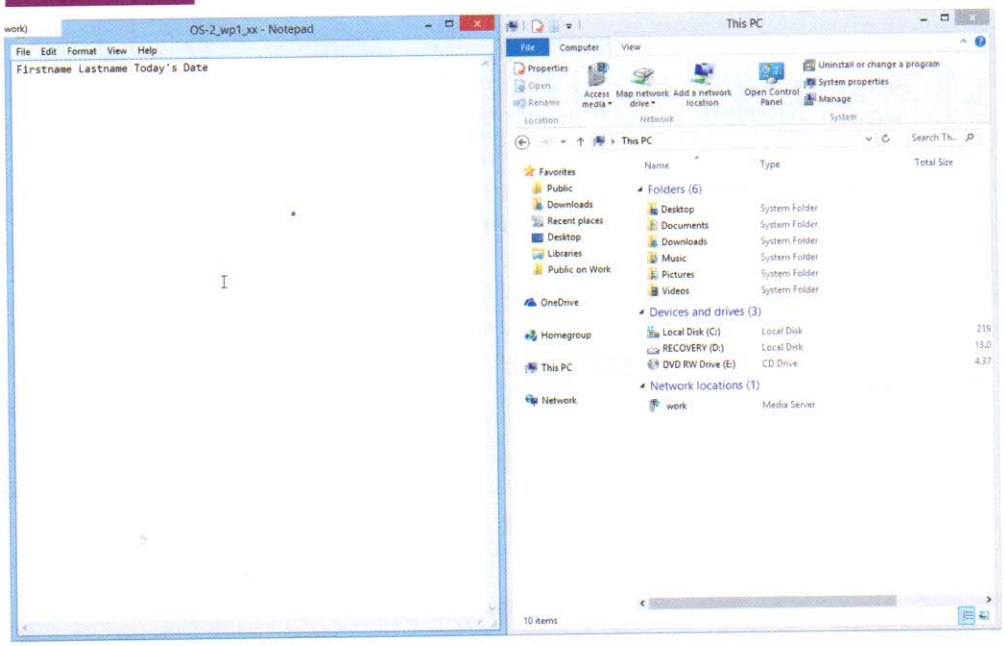


Operating System Activity 2: Exploring the Operating System

DIRECTIONS: *You will explore the features of your operating system. You will identify storage devices, network components, and installed printers, and you will locate information about the amount of installed RAM and processor speed for your system. To complete this activity, work in teams or small groups.*

1. Start your computer, and log in to your user account, if necessary.
2. Create a new text document named **OS-2_wp1_*xx*** in the location where your teacher tells you to store the files for this activity.
3. Start a text editor or word-processing program, and open **OS-2_wp1_*xx***.
4. Maximize the program window, if it is not already maximized.
5. Type your name and today's date in the file, and save the changes.
6. Minimize the program window.
7. Use your operating system to display available storage devices.
8. Count the number of available storage devices.
9. Make the text editor or word-processing program window active.
10. Arrange the two open windows side by side. Your desktop should look similar to Illustration B.
11. Cascade the two open windows.
12. Maximize the text editor or word-processing program window.
13. In the text document, press Enter to start a new line, type **Storage Devices:**, and then type the total number of available devices you counted in step 8. Save the changes.
14. Restore down the program window.
15. Make the PC window active.
16. Display the contents of a storage device. For example, double-click Local Disk (C:) or a removable device.
17. Display the components of your current network.
    ✔ *In the Windows Navigation pane, click Network.*
18. Close all File Explorer windows, leaving the word-processing program open.
19. Display a list of available printers.
20. Count the number of available printers.
21. Make the text document active, press Enter, type **Printers:**, and then type the total number of available printers you counted in step 20. Save the changes.
22. Display system information, including the amount of installed RAM and processor speed.
23. Switch to the text document, press Enter, type **RAM:**, and type the amount of installed RAM.
24. Press Enter, type **Processor speed:**, and type the processor speed. Save the changes.
25. Close all Control Panel windows.
26. With your teacher's permission, print **OS-2_wp1_*xx***, then close it and exit the program.
27. Close all open windows. With your teacher's permission, log off and/or shut down the computer.

Illustration B

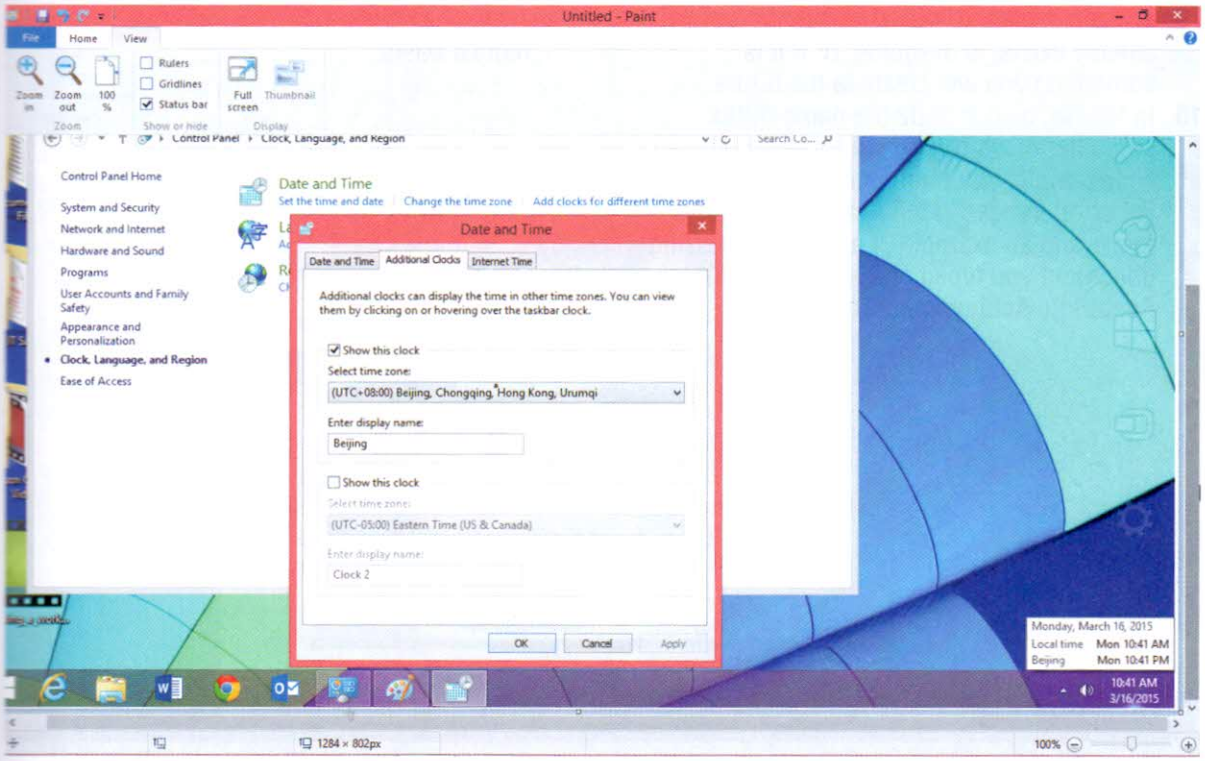


Operating System Activity 3: Customizing the Operating Environment

DIRECTIONS: *You will personalize your operating environment by customizing desktop icons and by changing the theme, desktop background, and window colors. You will capture an image of the desktop and paste it into a graphics file. Finally, you will reset all options to the previous configuration.*

1. Start your computer, and log in to your user account, if necessary.
2. If necessary, display the Desktop, and change the desktop display to show large icons.
3. Sort the icons on the desktop by name.
4. Sort the icons on the desktop by item type.
5. Personalize the desktop using a built-in theme. For example, if you are using Windows 8, apply the Flowers theme.
6. Personalize the desktop by applying a different picture to the background.
7. Personalize the desktop by changing the color of window borders.
8. Display options for adjusting the date and time display.
9. Synchronize the clock with Internet time.
10. Select to display an additional clock, showing the time in Beijing, China. Name the clock **Beijing**.
11. Make sure the Beijing clock is displayed. (In Windows 8, rest the mouse pointer over the clock/calendar in the taskbar to display a ScreenTip.) Then, capture an image of the desktop.
12. Start a paint or graphics program, such as Paint, and paste the captured image into the new blank file. Scroll the window so you can see the clock. It should look similar to Illustration C, depending on the options you select in step 7.
13. Save the file as **OS-3_image1_*xx*** in the location where your teacher tells you to store the files for this activity.
14. With your teacher's permission, print the file, and then close it and exit the program.
15. On the desktop, create a shortcut to the **OS-3_image1_*xx*** file, and then use the shortcut to open the file.
16. Resize the program window so it is about 4" high by 4" wide.
    - ✔ *If the window is maximized, you must restore it before you can resize it.*
17. Close the file, and exit the program.
18. Mute the speaker volume.
19. Restore the desktop settings, clock, and speaker volume to the way they were at the beginning of this activity.
20. With your teacher's permission, log off and/or shut down the computer.

Illustration C



Operating System Activity 4: Creating an Electronic Portfolio

DIRECTIONS: *You will use your operating system to set up an electronic portfolio. You will read about how to create a useful and effective portfolio, and then you will create a folder with subfolders where you can store items you select to include. You will convert printed items into digital files, and you will copy or move digital files into the portfolio.*

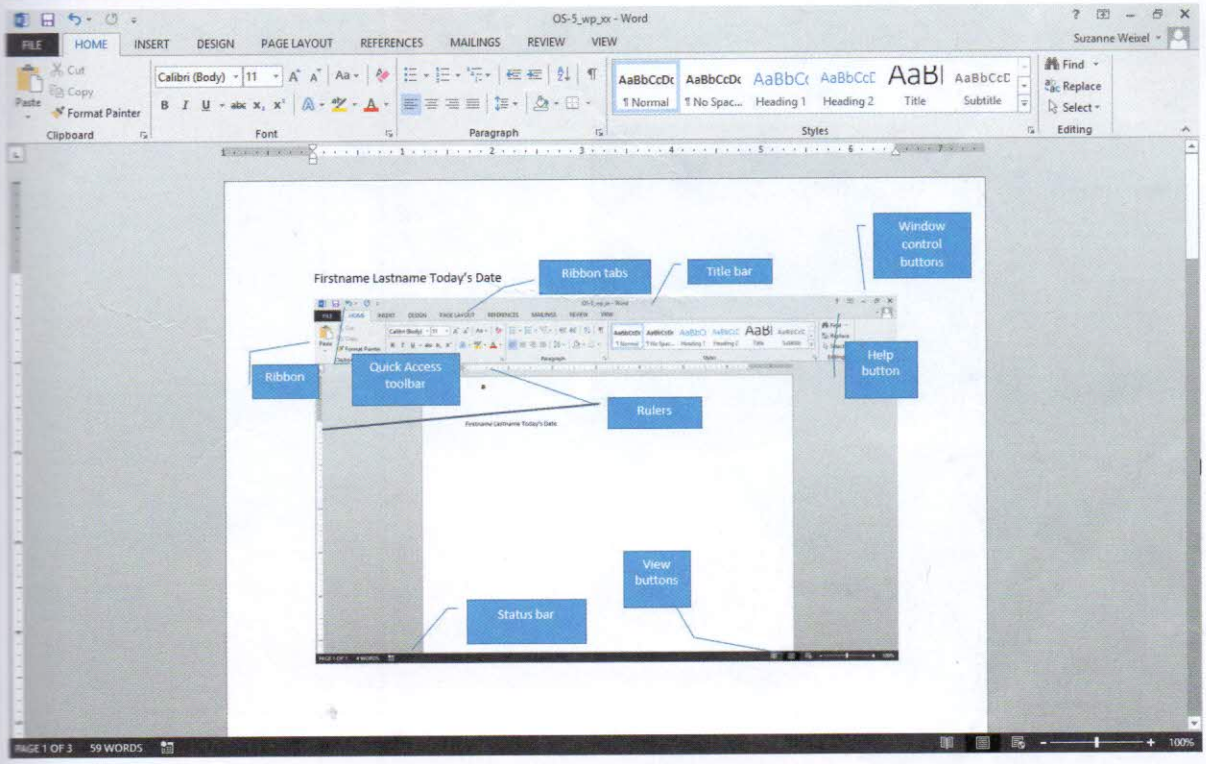
1. Open the .pdf file **OS-4_Portfolio**, from the data files for this course. This file contains information about electronic portfolios.
2. Read the information to learn about electronic portfolios.
3. In your operating system, navigate to the location where you want to store the electronic portfolio.
4. Create a new folder, and name it **OS-4_Portfolio_*xx***.
5. In the folder, create one subfolder named **Academic Achievement**, a second named **Personal Information**, and a third named **Career Information**.
6. Select an application that you can use to create a list of artifacts and other items you will include in your portfolio. This might be a word-processing program, a spreadsheet program, or a database program.
7. Use the application to create a new file. Save the file in the **Personal Information** subfolder, with the name **OS-4_List of Artifacts_*xx***.
8. In the file, list the name and a description of each artifact and item you want to include in the portfolio. (Refer to the information in the **OS-4_Portfolio.pdf** file.)
9. In the file, include whether each artifact already exists, is on-going, or if it is something you will create in the future.
10. In the file, also include the name of the subfolder in which you will store the artifact. For example, you might store a resume and list of references in the **Career Information** folder and an example of a word-processing document you typed and formatted in the **Academic Achievement** folder.
11. Save the file. You can modify it and refer to it as you develop your portfolio.
12. Locate existing artifacts and items you have stored in digital format and copy or move them into the appropriate subfolder in your **OS-4_Portfolio_*xx*** folder.
13. Locate printed artifacts and items, and use appropriate technology, such as a scanner or digital camera, to convert them into digital files. Store them in the appropriate subfolder in your **OS-4_Portfolio_*xx*** folder.
14. Select an application, and use it to create new items to include, such as a contact information sheet, a personal academic plan, and guidelines for assessment. Store the items in the appropriate portfolio subfolders.
15. Select an application, and use it to create reflections for your artifacts. Store the reflections with the artifacts in the portfolio.
16. Select an application, and use it to create a table of contents for your portfolio. Format the items as hyperlinks that link to the digital artifacts and items.
17. Practice presenting the portfolio to your class.
18. Continue to review, update, and add new artifacts and items to your portfolio on a regular basis.

Operating System Activity 5: Identifying Screen Elements

DIRECTIONS: *You will use your operating system to capture images of different program windows and insert the images into a word-processing file. You will then print the file and label the elements on each image.*

1. Start your computer, and log in to your user account, if necessary.
2. Start a word-processing application, such as Microsoft Word or Google Documents.
3. Save the default blank document with the name **OS-5_wp_*xx*** in the location where your teacher instructs you to store the files for this activity.
4. Maximize the application window.
5. On the first line of the word-processing file, type your first and last names and today's date.
6. Press Enter to start a new line.
7. Capture an image of the screen.
8. Paste the image from the Clipboard into the word-processing document.
9. Save the document, and then minimize the application window.
10. Capture an image of your computer desktop.
11. Restore the word-processing program window.
12. Press CTRL + ENTER to start a new page.
13. Paste the captured image into the word-processing document.
14. Save the document, and then minimize the application window.
15. Start a spreadsheet application.
16. Maximize the spreadsheet application window.
17. Capture an image of the spreadsheet application window.
18. Exit the spreadsheet application.
19. Make the word-processing application window active.
20. In the word-processing document, press CTRL + ENTER, to start a new page.
21. Paste the captured image into the word-processing document.
22. Save the word-processing document.
23. With your teacher's permission, print the word-processing document and label the parts of all three screens. Alternatively, use drawing tools to insert callouts or text boxes in the word-processing document to label the parts of the screens. Page 1, the word-processing screen, might look similar to Illustration D.
24. Close the word-processing document, saving all changes, and exit the application.

Illustration D

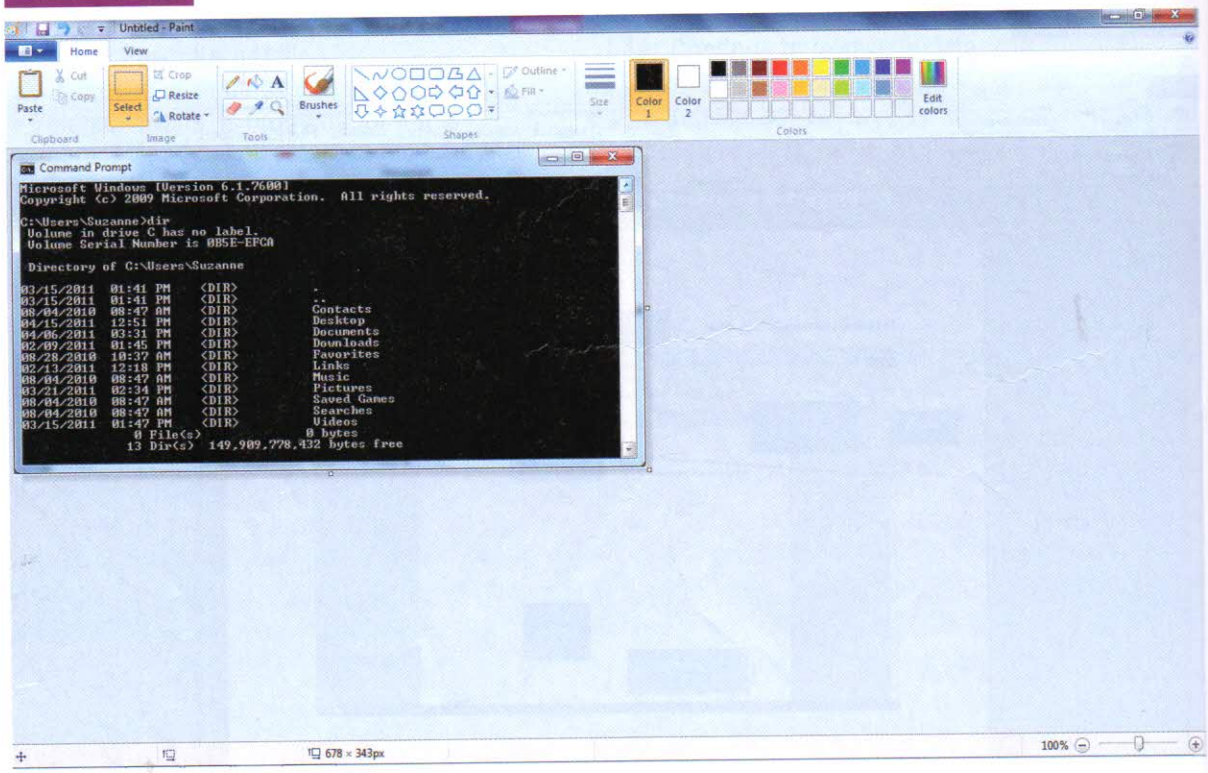


Operating System Activity 6: Using a Help Program

DIRECTIONS: *You will use a Help program to locate and review security settings. You will also access the command prompt and display a directory.*

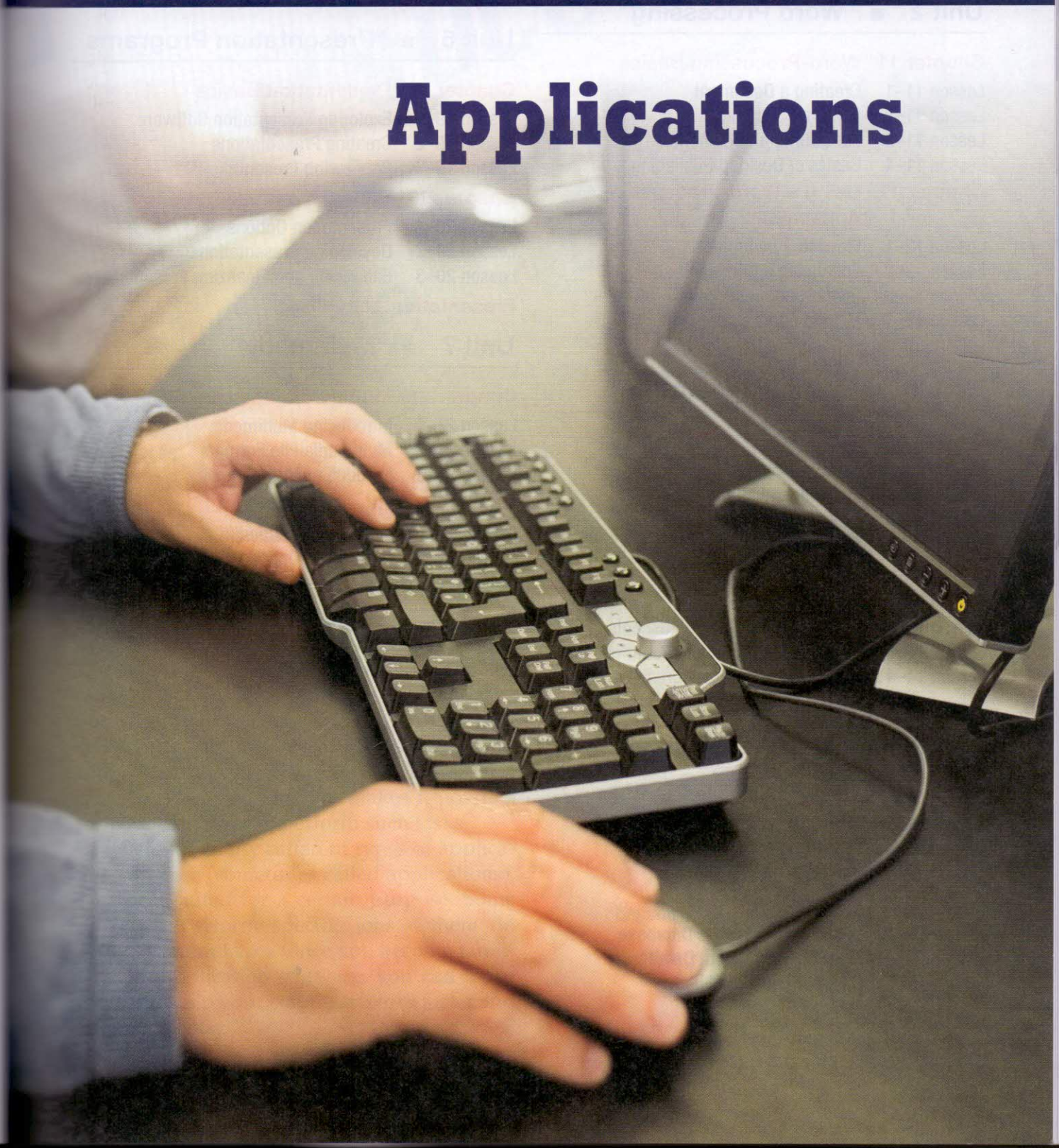
1. Start your computer, and log in to your user account, if necessary.
2. Start your operating system's Help program, and maximize the window.
3. Search for **managing security settings**.
4. Click a link for information about protecting your PC from viruses.
5. Read the information, scrolling down in the window until you reach the end.
6. Click the Back button to return to the previous window.
7. Search for information about antivirus protection. For example, in Windows, search for **Windows Defender**.
8. Click a link for more information, such as the link *Turn Windows Defender on or off*.
9. Click a link to open the program. If you are using an operating system other than Windows, click a link to open the window where you can view security settings.
10. With your teacher's permission, use the tabs on the page to view information about your antivirus program.
11. Close the window.
12. Close the Help program window.
13. If you are on a Windows OS, search for and open the Command Prompt. If you are on a Mac OS, skip to step 21.
14. Type **dir**, and press ENTER to display a directory list of files.
15. Capture an image of the command prompt window.
16. Start a paint or graphics program and paste the screen capture into the file. It should look similar to Illustration E, although the actual directory contents depend on the contents of your system.
17. Save the file as **OS-6_image1_*xx***.
18. Close the Command Prompt window.
19. With your teacher's permission, print **OS-6_image1_*xx***.
20. Close the file, and exit the program.
21. With your teacher's permission, log off and/or shut down the computer.

Illustration E



part 2

Applications



Unit 1 ■ Analyzing Applications

Chapter 9 Application Basics
Lesson 9–1 Selecting Application Software
Lesson 9–2 Obtaining Application Software
Lesson 9–3 Getting Started with an Application

Chapter 10 Understanding Applications
Lesson 10–1 Examining Types of Application Software
Lesson 10–2 Application Documentation and Versions
Lesson 10–3 Using Application Software

Unit 2 ■ Word Processing

Chapter 11 Word-Processing Basics
Lesson 11–1 Creating a Document
Lesson 11–2 Editing a Document
Lesson 11–3 Formatting a Document
Lesson 11–4 Basics of Desktop Publishing

Chapter 12 Using a Word-Processing Application
Lesson 12–1 Viewing a Document
Lesson 12–2 Enhancing a Document
Lesson 12–3 Formatting and Printing
Lesson 12–4 Making and Tracking Edits

Word Processing Activities

Unit 3 ■ Spreadsheets

Chapter 13 Spreadsheet Basics
Lesson 13–1 Exploring Spreadsheets
Lesson 13–2 Entering and Editing Data
Lesson 13–3 Using Formulas
Lesson 13–4 Sharing Data Among Programs

Chapter 14 Understanding Spreadsheets
Lesson 14–1 Formatting and Managing Worksheets
Lesson 14–2 Creating Effective Spreadsheets
Lesson 14–3 Automatic Spreadsheet Features
Lesson 14–4 Using Functions in a Worksheet

Spreadsheet Activities

Unit 4 ■ Databases

Chapter 15 Database Basics
Lesson 15–1 The Essentials of a Database
Lesson 15–2 Types of Database Programs
Lesson 15–3 Database Techniques

Chapter 16 Understanding Databases
Lesson 16–1 Creating an Effective Database
Lesson 16–2 Maintaining Efficient Databases
Lesson 16–3 Using Queries and Filters

Database Activities

Unit 5 ■ Graphics

Chapter 17 Graphics Basics
Lesson 17–1 Graphics and Their Uses
Lesson 17–2 Exploring Graphics Programs
Lesson 17–3 Working with Graphics

Chapter 18 Understanding Graphics
Lesson 18–1 Preparing Computer Graphics
Lesson 18–2 Exploring Image Editing Programs
Lesson 18–3 Draw and Animation Features

Graphics Activities

Unit 6 ■ Presentation Programs

Chapter 19 Presentation Basics
Lesson 19–1 Exploring Presentation Software
Lesson 19–2 Creating Presentations
Lesson 19–3 Previewing Presentations

Chapter 20 Enhancing Presentations
Lesson 20–1 Presentation Options
Lesson 20–2 Developing Presentations
Lesson 20–3 Enhancing and Finalizing Presentations

Presentation Activities

Unit 7 ■ Multimedia

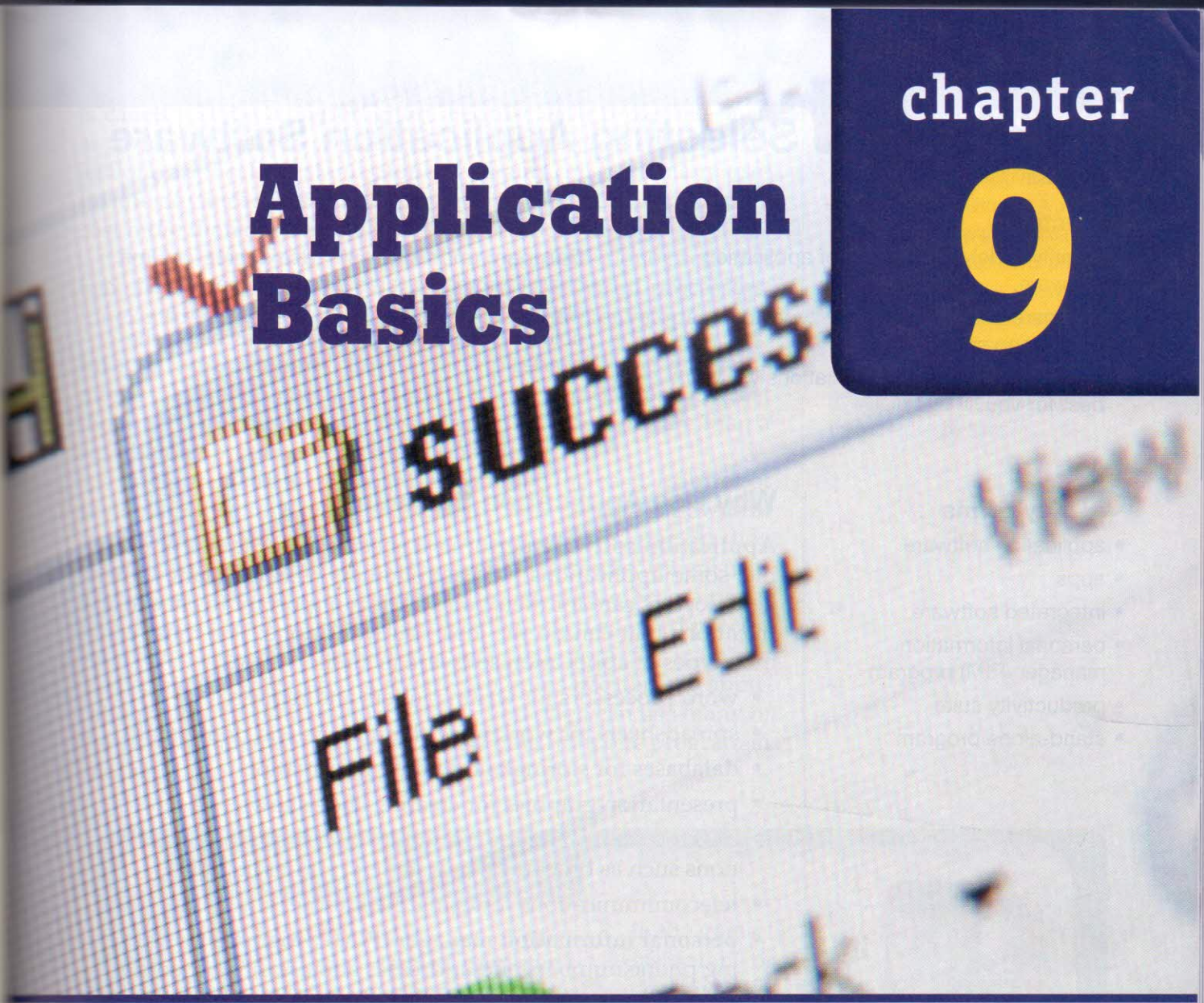
Chapter 21 Multimedia Basics
Lesson 21–1 Introducing Multimedia
Lesson 21–2 Multimedia File Formats
Lesson 21–3 Introducing Virtual Reality

Chapter 22 Understanding Multimedia
Lesson 22–1 Exploring Multimedia
Lesson 22–2 Developing Online Multimedia
Lesson 22–3 Exploring Virtual Reality

Multimedia Activities

chapter 9

Application Basics



What Is Application Software?

Application software is a type of program, such as word-processing or spreadsheet software, that directs a computer to perform one or more tasks. Think about all the things a computer can help you do. You can write letters and reports. You can look up information, record songs, play games, chat with friends, and more. Application software makes it possible for your computer to perform such tasks.

There are many different types of application software (sometimes called applications), each best suited for a certain purpose. Some programs perform specific jobs. Others do many different tasks. Once you become familiar with application software, you can make choices to help your computer work faster and more efficiently.

Chapter Outline

Lesson 9–1
Selecting Application Software

Lesson 9–2
Obtaining Application Software

Lesson 9–3
Getting Started with an Application

Lesson 9–1 Selecting Application Software

Objectives

- Identify widely used types of application software.
- Compare and contrast three types of application software.
- Decide what kinds of applications will work best for you.

As You Read

Compare and Contrast Use a three-column chart to compare three different types of application software. Write each type as a column header and list the features below the header.

Key Terms

- application software
- apps
- integrated software
- personal information manager (PIM) program
- productivity suite
- stand-alone program

Why Use Application Software?

Application software performs a specific job or task. For example, some applications help astronomers research stars. Others help doctors care for their patients. It is important to choose applications that can do the jobs you want done. The most common types of application software include:

- word processors for writing letters and reports
- spreadsheets for working with numbers and doing math
- databases for storing and finding information
- presentation graphics for creating slide shows
- desktop publishing for creating printer-ready publications such as brochures, newsletters, and invitations
- telecommunications for using the Internet and e-mail
- **personal information manager (PIM)** programs for storing phone numbers and addresses and creating schedules

Types of Application Software

Application software falls into three basic categories: stand-alone programs, integrated software, and productivity suites. These forms differ in their features (the tasks they do) and in cost. Wise computer users choose the type of software that best fits their needs, their computers, and their budgets.

Why Use Application Software?

Application	Purpose
Word-processing	Create text-based documents such as reports and letters
Spreadsheet	Display and analyze business, personal, or financial data
Database	Store and organize information
Presentation	Create and deliver multimedia slide shows
Desktop-publishing	Create publications such as brochures and invitations
E-Mail	Create, send, receive, and organize electronic mail messages

Stand-alone Programs Software that specializes in one task is called a stand-alone program. Because each program—such as a word processor, database, or spreadsheet—is dedicated to just one application, **stand-alone programs** can have many useful and advanced features. However, stand-alone programs may cost more than other forms of application software.

Because they focus on one kind of job, stand-alone programs usually have many very specialized features. Word processors, for example, give users tools to print labels and envelopes.

Integrated Software Buying multiple stand-alone programs might require too much memory in your computer or may cost too much. You might want to do more with the software than a stand-alone program is capable of handling.

Integrated software programs combine the basic features of several applications into one package. They are not as powerful or as complete as their stand-alone counterparts, nor do they specialize in one application. However, integrated software usually is less costly and is fairly easy to use. These programs let you do basic work in several applications such as word processors, databases, spreadsheets, graphics, and more.

People use integrated software programs because the applications work in similar ways. That is, you often can use many of the same commands. You also can use data from one program in another.

Connections

The Arts Software applications can be created to help make life easier for many different types of people. A software application called Goodfeel® converts printed sheet music to Braille, allowing blind musicians greater access to music. Before this software was created, blind musicians often had to wait months for sheet music to be converted by hand.

Spotlight on...

APPS FOR ALL

With its iPhone, Apple Computer pioneered the development of **apps**, third-party software programs developed specifically for smart phones, tablet computers, and other handheld devices. Apps are purchased from app stores, which are online portals where you select and download the programs. Basic versions of these apps are often free, although premium apps offering more features may cost anywhere from $2.00 to $200.00. Some so-called "free" games are designed so that the consumer can advance in the game faster if he or she pays a fee. These "free-to-play" games originally cost nothing but a player who is not careful can end up spending large amounts of money. Apps take up very little storage space—usually around 6–10 megabytes.

Available apps range from popular games like "Angry Birds," to practical apps that let you locate restaurants or count your calories.

Technology @ School

There are many advantages to using the same software at school and at home. For example, some programs allow you to use one computer to access files stored elsewhere.

Think About It!

For which reasons listed below would it be helpful to have the same programs at school and at home?

- I can work on my school projects at home.
- I can practice using the programs that I need at school.
- I can e-mail files to my teacher.

Productivity Suites What if you need to use the advanced features of several stand-alone programs? You might select a productivity suite. Although one suite may differ from another, in general **productivity suites** combine several programs such as word-processing, spreadsheets, databases, and graphics. Like integrated software, the programs in productivity suites have a common look and feel. But productivity suites contain more than the basic software found in integrated programs. They contain the actual stand-alone programs with all their features.

Productivity suites generally cost more than integrated software, but usually they are cheaper than buying the stand-alone programs separately. Some common productivity suites include:

- Microsoft Office (with Word, Excel, PowerPoint, Outlook, and Access in the Windows version)
- Corel WordPerfect Office (with WordPerfect, Quattro Pro, Paradox, Corel Presentations, and Corel CENTRAL)
- Adobe Creative Suite Design Premium (with Photoshop, Illustrator, InDesign, Dreamweaver, and Flash)

New Types of Applications

New types of software are always emerging. Current trends include applications that reside on Internet servers and applications that give everyday objects computing power.

Software as a Service Some companies are now making applications available for use online. For example, Microsoft offers a version of its Microsoft Office suite online, and Google offers Google docs. For free or a subscription fee, users can access the applications using an Internet connection instead of installing the program on their own computer.

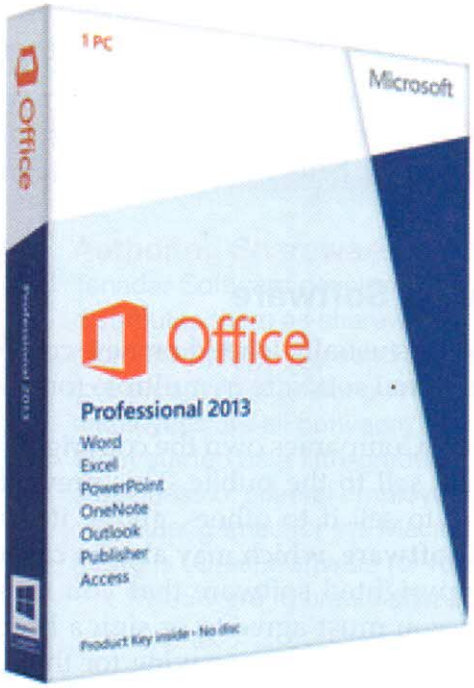
Pervasive Computing Now that so many objects have embedded computer chips, applications are emerging that let users interact with their things. For example, applications make it possible for you to use voice activated telephone calling in your car and to program your dishwasher to alert you when it is full.

Which Type of Software Is Right for You?

The type of application software you choose depends on what you want it to do, how much you are willing to spend, and how easy the programs are to learn. It also depends on whether the software will work on your computer and how much space each program will take up on your hard drive. You might want to match the software you use at home with the programs you use at school so you can work on documents in both locations.

While most computers are sold with some application software installed, your computer may not have the software you need. Your needs will also change over time. Consider how problems could arise if you use the wrong software product when you try to complete a specific task—like attempting to perform advanced mathematical calculations using a word-processing program. Whether you consider upgrading your existing software, buying new programs, or downloading free software from the Internet, you should consider the following:

- Reviews of the software. Consumer reviews are usually a great source of information.
- User-friendliness. What kind of support is available? Is there live help included?
- Licensing agreements (see Lesson 9–2). Can you agree to the licensing requirements? Remember that copying a friend's program is piracy.



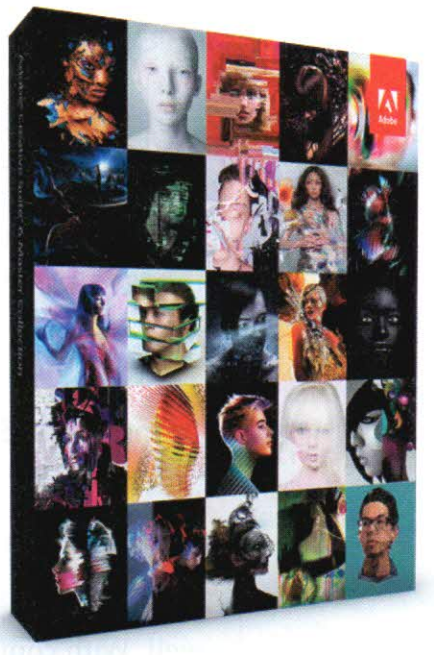


Figure 9.1.1 Popular productivity suites include Microsoft Office and Adobe Creative Suite.

Lesson 9–2 Obtaining Application Software

Objectives

- Explain why computer hardware and software must be compatible.
- Identify sources for obtaining application software.
- Explain the difference between proprietary and open-source software.
- Summarize the best way to install or uninstall application software.
- Analyze how piracy affects makers and users of computer software.

As You Read

Organizing Information Make an outline of the lesson. Use Roman numerals for main headings. Use capital letters for subheadings, and use numbers for supporting details.

Key Terms

- Cloud apps
- commercial software
- freeware
- open-source software
- proprietary software
- public domain software
- shareware
- single-seat license
- single-user license
- site license
- software license
- system requirement
- volume license
- Web apps

Minimum System Requirements

Each software program has minimum **system requirements**. The computer must meet the minimum hardware and software needs of the program for it to work properly.

To get the most from your computer, it is important to choose software that will work with the following:

- your type of computer (Macintosh or PC compatible)
- microprocessor speed
- operating system (such as Linux, MAC OS X, or Windows)
- available amount of memory (RAM)
- available hard drive space
- special equipment, such as a DVD drive

Software that is not compatible with your system will not work. Worse, trying to install incompatible software may damage your computer. To avoid compatibility problems, double-check the system requirements before buying or installing any software program.

Obtaining Application Software

Some application software is usually loaded on new computers. You can also obtain additional software in multiple forms.

Commercial Software Companies own the copyrights to the application software they sell to the public. This prevents you from illegally copying it to sell it to others, giving it away, or sharing it. **Commercial software**, which may also be called **proprietary software**, is copyrighted software that you must buy before using it. Usually, you must agree to or sign a license, as well. With commercial software, you are paying for the right to use the software, not necessarily for the right to the software's code. Software where the user doesn't gain access to the program's code is also called closed-source software.

Shareware Proprietary software that you can use on a try-before-you-buy basis is called **shareware**. If you decide to keep using it, you must pay a registration fee. You are also allowed to copy shareware and give it to your friends. They must follow the same process to acquire the software.

Freeware Some companies give away their copyrighted software for free. This is known as **freeware**. The companies allow users to install the program as long as they do not resell it.

Open-Source Software This kind of software makes the source code available to the public. The idea is that the software will improve and benefit from the innovations of users, who troubleshoot weak points and expand features. Critics, however, say that developers are not fairly compensated for their work (open source is not automatically "free") and also that the software development suffers if there is no central organizer.

Creative Commons A creative commons license lets software copyright holders open some of their work for public use while letting them hold onto other parts of their work. As with open-source software, there are critics who complain that creative commons licenses eat away at intellectual property rights. Yet, several million pages of Web content are "brought to you" by Creative Commons licenses, such as The Library of Public Science, Garageband.com, and Flickr, the photo sharing site.

Public Domain Software On occasion, program authors allow you to use programs, share them, give them away, or even alter them to meet certain needs. This is called **public domain software**. Beware: the quality of these programs can vary widely, and they may contain more errors than other types of software.

Technology @ Work

Shareware companies make money by collecting fees for the products they send out on a free trial basis.

Think About It!

Shareware has many advantages for its producers. Identify each benefit of shareware listed below as either true or false.

- A user might try shareware rather than opting to buy a commercial program.
- Shareware companies do not have to pay for distribution.
- Users who do not like the product still have to pay for it.

Real-World Tech

Authoring Shareware California-based Tenadar Software develops adventure games and distributes them as shareware. To play the game more than once, you send the requested royalty to the copyright holders. Who are they? Tenadar employees are all between 10 and 12 years old. What started as a fifth-grade project has grown into a business of several employees offering a variety of computer games for the Macintosh. The company's motto is "Great Software for Kids, by Kids."

If you were to create shareware, what might you choose to develop?

Installing, Reinstalling, and Uninstalling Programs Application software must be installed, or prepared to run on a computer, before it can be used. You must copy it from a location such as an installation disk or download it from the Internet to the computer's hard drive.

Most programs come with an installation, or setup, program that prompts you to load the software onto the computer. Companies that make commercial software often provide printed or online guides, telephone support, or online help to solve installation problems.

To delete a program from the computer, you must run a special removal program to properly uninstall it. Otherwise, parts of the program can remain on the computer and may interfere with its operation. You can reinstall the program if you need it again, or to repair a problem.

Using Web Apps **Web apps,** which are sometimes called **Cloud apps,** are applications that are stored on cloud servers so you do not have to install them on your computer. Usually, you must register with a Web site to use a Web app. Some common Web apps include online e-mail services such as Gmail and Yahoo mail, social networking sites such as Facebook and Twitter, and productivity suites, such as Google Docs and Office 365.

Using Software Legally

Buying proprietary, copyrighted software comes with a **software license**, which allows the buyer to use and install the program, and sometimes entitles the buyer to receive free or reduced cost support and updates. Individuals might buy a **single-user license** for one copy of the program, or a **single-seat license** to install the program on a single computer. Organizations such as schools or businesses usually buy a **volume** or **site license** which lets them install on multiple systems or a network for multiple users. Network licensing generally costs less per user and allows users to share resources.

Figure 9.2.1 Most software programs come with a license agreement, like the one shown here for Windows 8.1 Pro.

MICROSOFT SOFTWARE LICENSE AGREEMENT

WINDOWS 8.1 PRO

Thank you for choosing Microsoft Windows 8.1 Pro. This is a license agreement between you and Microsoft Corporation (or, based on where you live, one of its affiliates) that describes your rights to use the Windows 8.1 Pro software. For your convenience, we've organized this agreement into two parts. The first part includes introductory terms phrased in a question and answer format; the Additional Terms and Limited Warranty follow and contain greater detail. You should review the entire agreement, including any linked terms, because all of the terms are important and together create this contract that applies to you. You can review linked terms by pasting the forward link into your browser window once the software is running. **The Additional Terms contain a binding arbitration clause and class action waiver. If you live in the United States, these affect your rights to resolve a dispute with Microsoft, so you should read them carefully.**

By accepting this agreement or using the software, you agree to all of these terms and consent to the transmission of certain information during activation and for Internet-based features of the software. If you do not accept and comply with these terms, you may not use the software or its features. Instead, you should return it to the retailer for a refund or credit, if any.

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Lesson 9–3

Getting Started with an Application

Objectives

- Describe how to launch a program.
- List common features of application software windows.
- Explain how to maximize and minimize a program window.
- Explain how to create, open, save, and close a file.
- Explain how to exit an application.

As You Read

Draw Conclusions Use a conclusion chart to help you understand how to use application software as you read.

Launching an Application

To get started with an application program, you open it using the operating system on your computer. Most applications use similar commands to accomplish basic tasks, such as starting, exiting, and saving. Once you learn these tasks in one program, you can easily transfer the knowledge so you can use other programs, too.

Starting a Program When a computer is turned on, it typically starts its operating system. You can then **launch**, or start, any application installed on the computer. You can launch an application in two ways: a menu or an icon.

- Menu—In Windows 7 or earlier, clicking the Start button displays a list of programs installed on the computer.
- Icon—Icons, which may be called tiles, are on-screen symbols that stand for a computer function or program. Because they are shortcuts to programs, it is helpful to customize your desktop or Start screen to include icons for the programs you use most often.

Exploring Application Windows

A launched application appears in a frame called a window. You can work in any size window, but it is usually best to **maximize** the window, or make it as large as it can be. Sometimes you will want to use another program without closing the first one. You can resize it or **minimize** it to make it as small as possible so it remains out of the way while you use the other program.

Key Terms

- command
- groups
- launch
- maximize
- menu bar
- minimize
- Ribbon
- scroll
- tab
- title bar

Figure 9.3.1 The Windows 7 Start menu.

Did You Know?

If you've used a Web browser, you may have found yourself faced with pop-up windows. It may be annoying, but you can make these windows go away. In Windows, right-click the task bar button and click Close. Macintosh users can press the Command and W keys together.

The largest portion of an application window is the space for your work. The rest of the window contains tools that you use to develop your files.

Title Bar The top row of an application window is called the **title bar**. The title bar shows the program's name and, in some cases, the name of the document you are working on.

The Ribbon In Microsoft Office, the **Ribbon** is the control center for using the application. The Ribbon has three parts:

- **Tabs.** Each **tab** contains important tasks you do within an application. For example, the Home tab in Excel offers formatting and formula options.
- **Groups.** Each tab contains **groups** of related tasks. For example, in Excel, the Number group on the Home tab offers number formatting options.
- **Commands.** A **command** is a button, a box for entering information, or a menu. For example, the % button in a spreadsheet program formats a number as a percentage. Click a command to select it or use a shortcut key combination. For example, press and hold Alt and then press the shortcut key identified in the command name.

The Menu A **menu bar** lists sets of commands. On a Macintosh, it appears at the top of the screen. In Windows applications, the menu generally appears under the title bar.

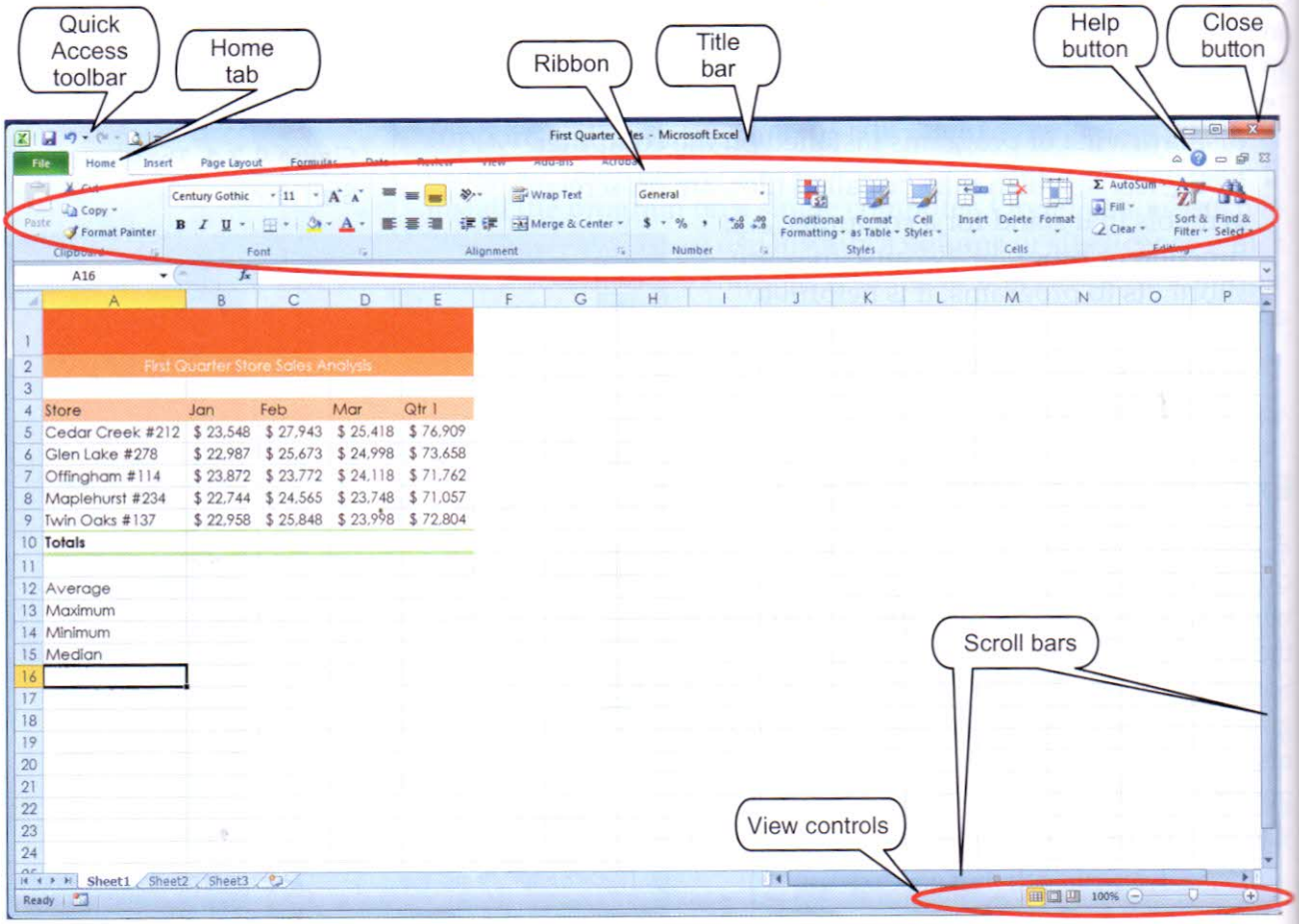


Figure 9.3.2 Applications in the Microsoft Office software suite share these basic elements.

Creating, Opening, Saving, and Closing

Application software lets you create new documents, save them for future use, or work on documents you have saved. You can close the application when you are done working. Most applications have a File menu (see below)—though the 2007 version of Microsoft Office has an "Office" button—which includes these commands:

- New—creates a file into which you can enter data
- Open—finds a document that was previously saved as a disk file and displays it in a window
- Save—saves the document in the current window to a disk file
- Save as—saves the document as a new file with a new name, in a different location, or in a different format
- Close—closes an open file
- Exit or Quit—closes the application and removes its window from the screen

Moving in the Application Window

Some tools allow you to **scroll**, or move from one part of a window to another. The scroll bars usually appear at the right side of the window and at the bottom. Boxes appear in these bars to show whether you are at the beginning or end of the file or somewhere in the middle. You can move from one place to another by either dragging these scroll boxes or clicking the scroll arrows at each end of the scroll bars.

Technology @ Work

Many jobs have been created in the computer industry. Thanks to the way we rely on computers, many companies hire staff who have computer skills but possess degrees in other fields, such as history or science.

Earning a certificate in a computer-skill area is one way to show today's companies that you have computer training. MOS (Microsoft Office Specialist) certification confirms the user is proficient with Microsoft Office programs such as Word, Excel, PowerPoint, or Access.

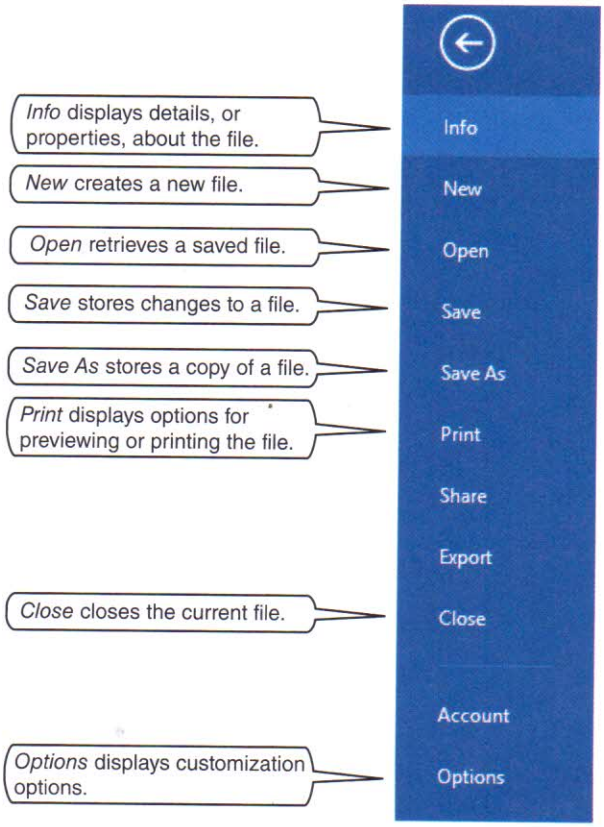


Figure 9.3.3 In Microsoft Office, use the File menu in Backstage view to access commands for creating, saving, printing, and managing documents.

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

C	1. personal information manager	a. software that you can try before purchasing
g	2. integrated software	b. uncopyrighted software that is given away without cost
d	3. productivity suite	c. software that stores phone numbers and creates schedules
a	4. shareware	d. combines several full-featured programs in one package
b	5. freeware	e. third-party software programs developed specifically for certain smart phones
f	6. public domain software	f. to delete a program from the computer
i	7. uninstall	g. combines basic features of several applications into one package
e	8. maximize	h. move from one place in a window to another
h	9. apps	i. to make a window as large as possible
	10. scroll	j. copyrighted software that is given away without cost

Check Your Comprehension

Directions: *Determine the correct choice for each of the following.*

1. Which of the following items is NOT an example of application software?
   - a. spreadsheet
   - b. database
   - c. operating system
   - d. word processor
2. Which of the following types of application software combines the basic features of several applications?
   - a. stand-alone program
   - b. integrated software
   - c. productivity suite
   - d. personal information manager (PIM) program
3. Which of the following types of software must be purchased in advance?
   - a. commercial software
   - b. shareware
   - c. freeware
   - d. public domain software
4. Which of the following types of software is available on a try-before-you-buy basis?
   - a. commercial software
   - b. shareware
   - c. freeware
   - d. public domain software
5. Which of the following features allows the user to launch an application?
   - a. Help menu
   - b. menu bar
   - c. title bar
   - d. desktop icon
6. Which of the following tools allows the user to move from one part of a window to another?
   - a. scroll arrows
   - b. scroll icons
   - c. scroll menu
   - d. scroll file

Think Critically

Directions: *Answer the following questions.*

1. Why might a programmer choose to release software as open-source instead of as proprietary?

2. Why should you check a program's system requirements before purchasing it?

3. Why is it important to uninstall a program you no longer use?

4. What is the difference between the New and Open commands on the File menu?

5. Why does an application window include tools such as scroll bars, scroll boxes, and scroll arrows?

Extend Your Knowledge

Directions: *Choose and complete one of the following projects.*

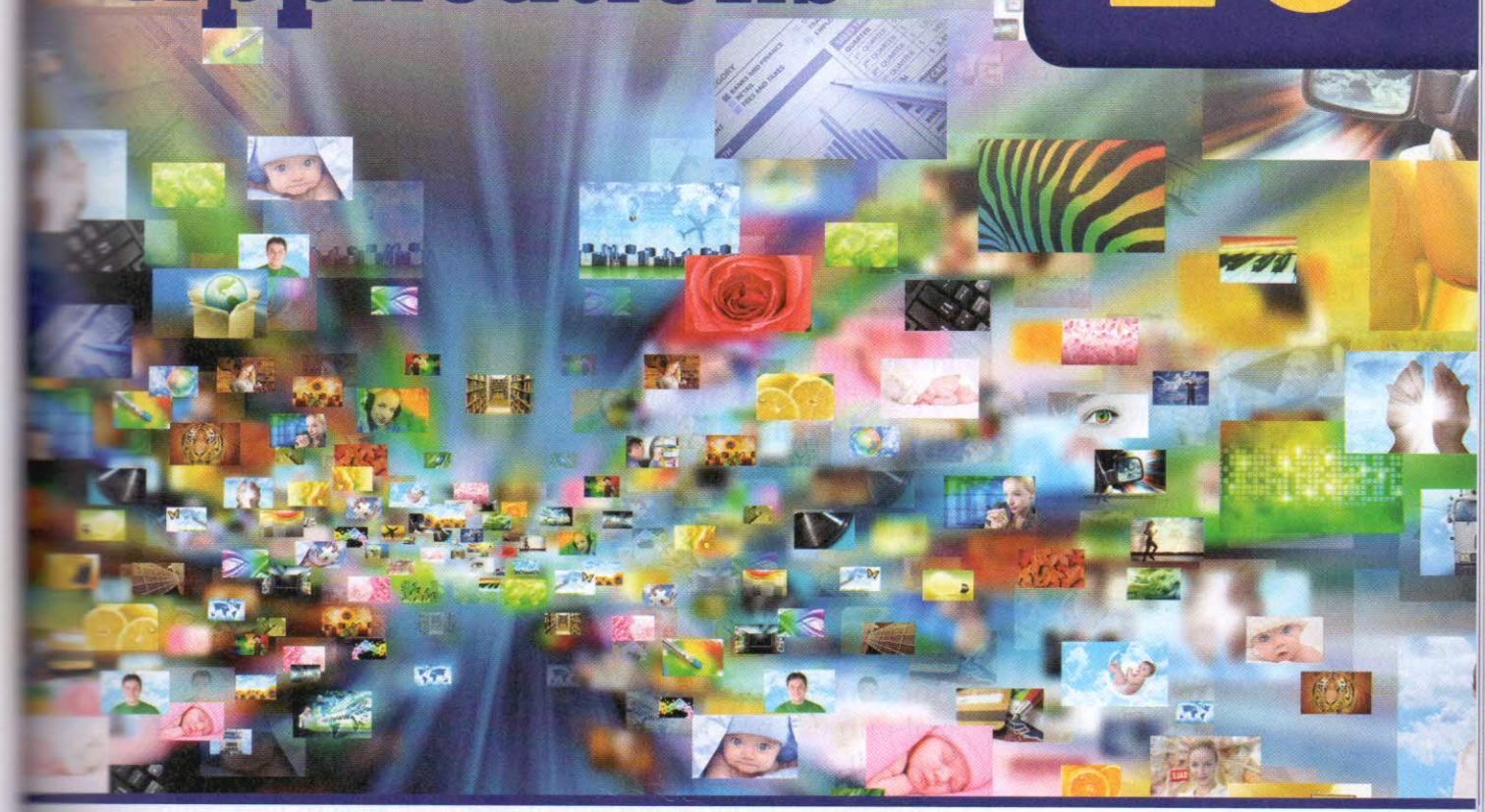
A. The computer desktop shows many different types of icons. Icons can represent applications, files, or file folders. Experiment with a Macintosh or Microsoft Windows operating system. Make a three-column chart of the icons that appear on the desktop. Include a description of what happens when each icon is clicked, and identify what type of file or program the particular icon represents.

B. Several types of application software are listed in this chapter. They include word processors, spreadsheets, databases, presentation graphics, telecommunications, and personal information managers. Using the Internet or other resources, prepare a report that evaluates, compares, and contrasts at least two types of application software that you may use based on their appropriateness for a task, licensing agreements, and available support. As you work, take notes and keep track of your sources. Include a list of sources or bibliography with your report. Evaluate the information you find and only use it if it is accurate, relevant, and valid. Share your report with the class.

chapter

10

Understanding Applications



How Can an Application Help You?

Application software provides the tools you need to get a job done. When you select the right program for the job, you can accomplish the task quickly and efficiently.

Applications are designed to meet different needs. Some are designed for one specific purpose, such as managing medical records or product inventory. Some are designed for multiple purposes, such as creating presentations on any subject.

In this chapter, you examine application software more closely. You learn more about types of applications and how to use an application program to complete a task.

Chapter Outline

Lesson 10–1

Examining Types of Application Software

Lesson 10–2

Application Documentation and Versions

Lesson 10–3

Using Application Software

Lesson 10–1

Examining Types of Application Software

Objectives

- Compare and contrast horizontal and vertical applications.
- List examples of horizontal and vertical applications.
- Describe the role of beta versions in the software-testing process.

As You Read

Organize Information Use an outline to organize information about application software as you read.

Key Terms

- beta version
- copy protection
- horizontal application
- personal productivity program
- premium apps
- time-limited trial
- vertical application

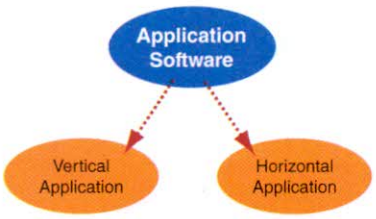


Figure 10.1.1 Vertical application software is very specific—such as the computer-aided design programs used by architects—and horizontal application software—such as Microsoft Word—can be used by all types for everyday computing tasks.

Which Direction Is Right for You?

Application software can be classified as a stand-alone, integrated, or productivity suite program. These types of software differ in the number of tasks they perform. Another way to classify application software is based on whether it is developed for a few users with very specific needs or whether it appeals to many users with shared needs.

Vertical Application A **vertical application** is designed for a very limited purpose, such as restaurant management or medical billing. Although the software is very useful to one field or business, it is of little interest to others.

Horizontal Application A **horizontal application** is a general-purpose program that meets the needs of many different users. It can be applied to many tasks. It also tends to be less expensive. It is likely that you will use horizontal, not vertical, applications for schoolwork you do on the computer. Horizontal applications are also used in many households to track finances and prepare tax forms.

Types of Horizontal Applications

Horizontal applications can be divided into several categories depending on the focus of the program.

Personal Productivity Programs The most popular horizontal applications are known as **personal productivity programs**. They help people work more effectively and include common applications such as word processors and database systems.

Multimedia Applications Some horizontal applications combine text, graphics, video, and sound. These include:

- desktop publishing—to combine text and graphics to produce newsletters and brochures
- graphics—to create and edit pictures
- Web page design—to create Web pages using sound, graphics, animation, and text

Internet Applications Some horizontal applications help computer users communicate over the Internet, including:

- Web browsers—to access data from the World Wide Web
- e-mail—to send and receive electronic messages

Online or Mobile Apps Applications designed for use online are called online apps, Web apps, or Cloud apps, while those designed to download and use on a smart phone or tablet are called mobile apps. They are available for thousands of uses, from productivity suites to games. Some are free, and some, called **premium apps**, must be purchased.

Apps have a range of uses from playing music to helping improve productivity. Some apps even track a user's health and exercise. Apps that use the Internet can connect to a web browser, a user's e-mail, or social media sites, such as Facebook and Twitter. There are also reference apps you use to search for information; creation apps for drawing or creating images; and content apps for organizing data, like the contacts on your phone. Like computer applications, apps are written to run on a specific operating system so not all apps run on all mobile devices.

Testing Software

Beta versions, or early working copies of application software, are often sent to selected users to test the program. They use it for a period of time and report errors or problems to the developer. Beta versions help ensure that the final software will work correctly and offer customers the best tools possible.

Limited Trials To protect their work and guard against illegal copying, companies may set their beta software to expire after a certain date. These **time-limited trials** stop working after a certain number of uses or days.

Technology @ School

Most schools run horizontal applications to help students and staff perform everyday computing tasks. These commercial programs meet the needs of most computer users most of the time.

Think About It!

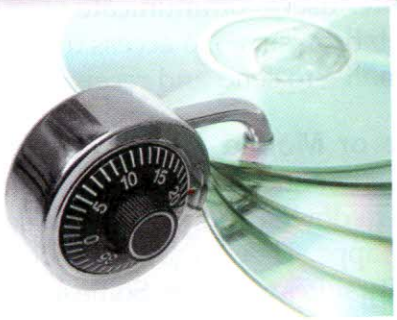
With permission, look at several computers at school, including one in the library and one for classroom use. Which of the following horizontal applications did you find?

- word processing
- spreadsheet
- database
- presentation graphics
- other?

Copyright Concerns Developers sometimes add **copy protection**, a physical device or software tool to keep users from making unauthorized copies of the beta software. These copyright safeguards can protect the sellers' property from illegal copying—a serious crime. Copy protection prevents beta software, which is still in development, from being widely distributed.

Real-World Tech

Protecting Digital Media Copy protection extends beyond software. Any form of information that is stored digitally is at risk of being illegally copied, including CD music and DVD movies. An early attempt by Sony Corporation to copy-protect CDs sold across Europe failed. It turned out that consumers could defeat the copy-protection method too easily.



Why do you think companies continue to research new and better ways to copy-protect their work from unethical and illegal duplication?

Application Documentation and Versions

Lesson 10–2

Objectives

- Compare and contrast types of documentation.
- Explain the purpose of versions and version numbers.
- Describe why it is important to register your software.

As You Read

Cause and Effect Use a cause-and-effect chart to help you understand the results of various software elements.

Key Terms

- documentation
- knowledge base
- maintenance release
- product key
- troubleshoot
- version

Software Documentation

Most software packages provide directions on how to install the program, to use the application, and to **troubleshoot**, or correct, problems. These instructions, called **documentation**, are typically available in three forms:

- printed tutorials and reference manuals
- electronic help screens in the program or on CD-ROM
- information available on the publisher's Web site

Printed Documentation Installation instructions may be a single sentence printed on the software disk or CD. Other instructions may take the form of a booklet. Some programs include encyclopedia-type references that detail the software features.

Electronic Help Screens Application software frequently provides reference materials in electronic form as part of the program or on a separate CD or DVD. Opening the program's Help menu lets you troubleshoot problems as they happen and find out how to perform certain operations or tasks.

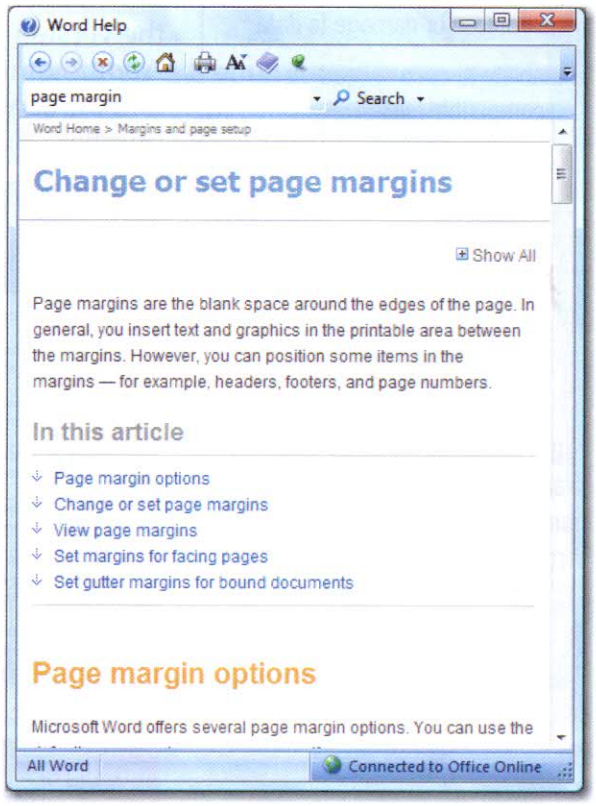


Figure 10.2.1 Most software programs provide help screens, like this one.

Technology @ Work

There is a gradual but steady shift in most companies away from outputting files in hard copy (printed) to outputting soft copy (digital or electronic files). Digital output includes any information displayed on a computer, including application files, e-mail, e-mail attachments, and Web pages.

Think About It!

Outputting files electronically is convenient, fast, and can save costs related to printing and mailing. It also poses some risks. Which of the following issues do you think poses the greatest risk to companies and individuals?

- lack of hard copy documentation
- risk of unauthorized access to data
- risk of loss or damage to data
- inability to open or read incompatible files

Web Sites Software documentation sometimes may be found on the software publisher's Web site. These sites often include answers to users' frequently asked questions (FAQs) and give other helpful hints. Files, sometimes called patches, may be available to fix, or patch, problems with the software. More so than other types of support, Web documentation can be updated quickly by the publisher and shared with users who need it.

Other Sources If you need more information than is provided by the software's documentation, telephone or online support may be an option. Many software companies maintain an online **knowledge base** that users can search to find information and get help. In addition, many helpful application software references and tutorials are available in libraries, online, or at bookstores.

Versions of Software

Successful software can lead to multiple **versions**, or releases. Companies typically identify their new software with a version number. A version can be identified by the year it was released, such as Microsoft Word 2013. Sometimes the version number is a whole number followed by a decimal or a letter, such as 5.D or 6.22. Smaller numbers such as 1.2 or 1.2a indicate a **maintenance release**—a minor revision to correct errors or add minor features. A larger number indicates that the software has significant revisions with new features.

The version number may not be obvious when an application launches. However, most software manufacturers locate the version number in the Help menu, where you can select the About command. This will open a window with useful information about the software—including its version and revision number.

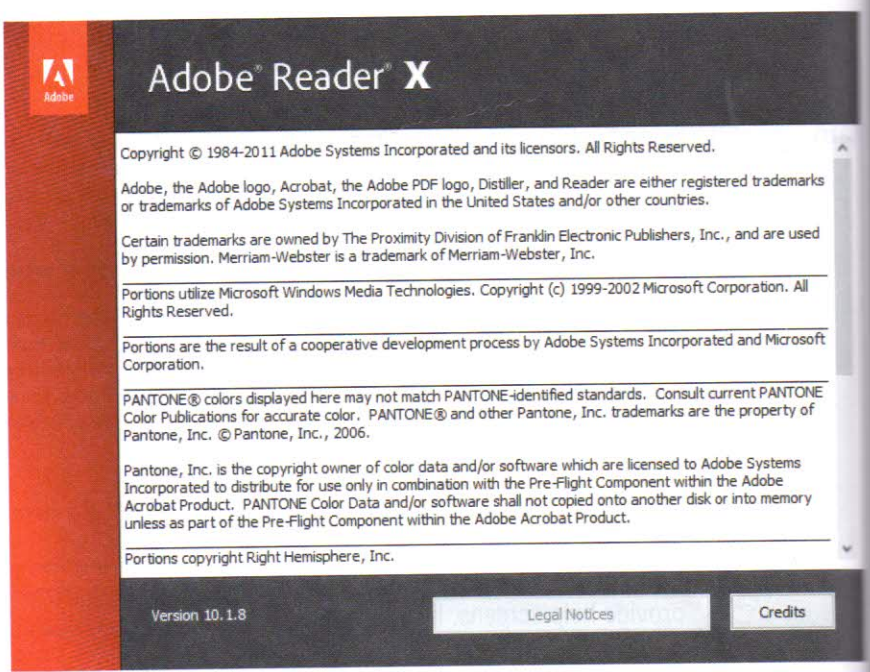


Figure 10.2.2 In most programs, you can find the version number and other information through the Help menu.

Software Registration and Protection

When you install software, you are typically asked to register, or be recorded as the owner of your copy, with the publisher. You can register by faxing or mailing a printed form that comes with the package or by completing an online form that can be sent to the software manufacturer. Sometimes registration is part of the program activation. To activate the program, you usually enter a license number, called a **product key** or product code, and agree to an End User License Agreement (EULA).

Registration allows you to use the software legally. Since the software company knows you have a legal copy of its product, it may offer services such as free technical support. The company may also send notices of new version releases or upgrades offered at no cost or at a discounted price.

Organizations that have many computers—such as schools, businesses, or government agencies—may purchase a site license instead of registering individual copies of the software. A site license, which may be called a multi-user or volume license, usually includes one product key for all users, and gives permission to install the software on a specific number of computers for the organization's internal use only. On the other hand, a single-user or single-seat license, provides one key per copy.

Technology @ Home

One type of software sees seasonal increase in sales. Every spring, many families purchase tax preparation software to assist in preparing annual federal tax returns to send to the Internal Revenue Service by April 15, the filing date.

Think About It!

Some revisions in tax preparation software are out of the control of the programmers. Of the reasons listed below for a revision, which do you think developers could not have predicted?

- bugs in the program
- changes in tax laws
- changes in the data user's input

Spotlight on...

NORAH SCHOLL

"Easter Seals' award-winning Assistive Technology program . . . makes me more independent."

Norah Scholl

She is the fastest typist in her grade. Why is that so special? Well, Norah Scholl cannot use her hands. Thanks to upgraded software provided by Easter Seals and special hardware, she does many of the things other middle-school students do.

Norah is the youngest person ever to master the special software that now allows her to speak into her computer to operate it.

Lesson 10–3 Using Application Software

Objectives

- Identify and describe common features of application software.
- Explain how default settings can be changed to suit a user's needs.
- Explain the benefits of multitasking.

As You Read

Summarize Use a chart to summarize the purpose of each common feature of application software as you read.

Key Terms
- application workspace
- command button
- default
- menu
- multitask
- preference
- Print Preview
- status bar
- tab
- toolbar
- zoom

Working in an Application's Window

There are several common features you are likely to find in your application windows. You use a mouse or keyboard to navigate in the window, to make selections, and input commands.

Application Workspace The largest area of a program's window is called the **application workspace**. It displays the file in which you are working. You can enter text, graphics, or other data into the workspace. You also can locate and open a saved file into the application workspace. The workspace looks different depending on the application. For example, a word-processing application workspace looks like a page; a spreadsheet workspace looks like a grid of columns and rows.

Title Bar The title bar usually displays the name of the application and the name of the file you are in. If this is a new document, you will see a placeholder name, such as *Untitled* or *Document 1*.

Toolbar and Command Buttons Most applications have a **toolbar** or **command buttons** that you use to select a command. A toolbar is a row of icons or buttons. Clicking a toolbar icon or command button tells the application to execute that command.

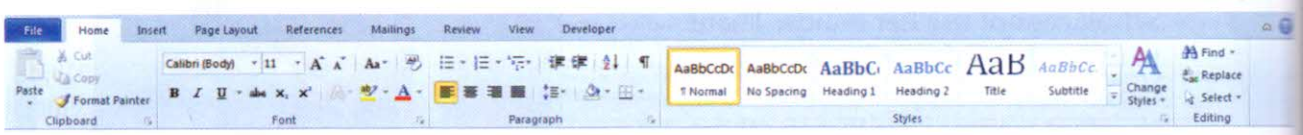


Figure 10.3.1 The Ribbon in Microsoft Office programs provides easy access to commands. Other programs may use toolbars or menus.

Some applications have more than one toolbar. Many toolbars can be dragged to a different location, if desired, or even "floated" in the application workspace.

Menus and Tabs **Menus** and **tabs** give you access to the program's commands. They present a list—or menu—of choices so you can select the one you need.

Viewing a Document Many programs let you change how a document is displayed in the application workspace. Changing the view can help you accomplish specific tasks. For example, you might change to **Print Preview** to see how a file will look when it is printed, or change to Draft view when you do not need to see features such as graphics or columns.

Adjusting the Display You can adjust the display of the data in the workspace by using the **zoom** control. This option magnifies the view of the document. You typically can set it to any size you prefer between 10 percent and 500 percent. Zoom options do not affect the printing size, only how you see your document on the screen. A 100 percent magnification shows the document at the same size that a printed copy will be.

Protected Mode Some programs automatically open certain files in protected mode, or protected view, which means most editing functions are disabled. For example, Microsoft Office programs open files downloaded from the Internet or received as an e-mail attachment in protected mode. Protected mode can help protect your computer from viruses and other malware. You can click the Enable Editing button to exit protected mode.

Read-Only View Most programs let you set properties to open a document or file in read-only view, which means you can read it but not edit it.

Career Corner

Software firms need employees with strong people skills as well as knowledge of the programs they develop.

Customer-support technicians provide assistance to customers who need help with products. Sometimes help is offered by phone; other tech support is offered online.

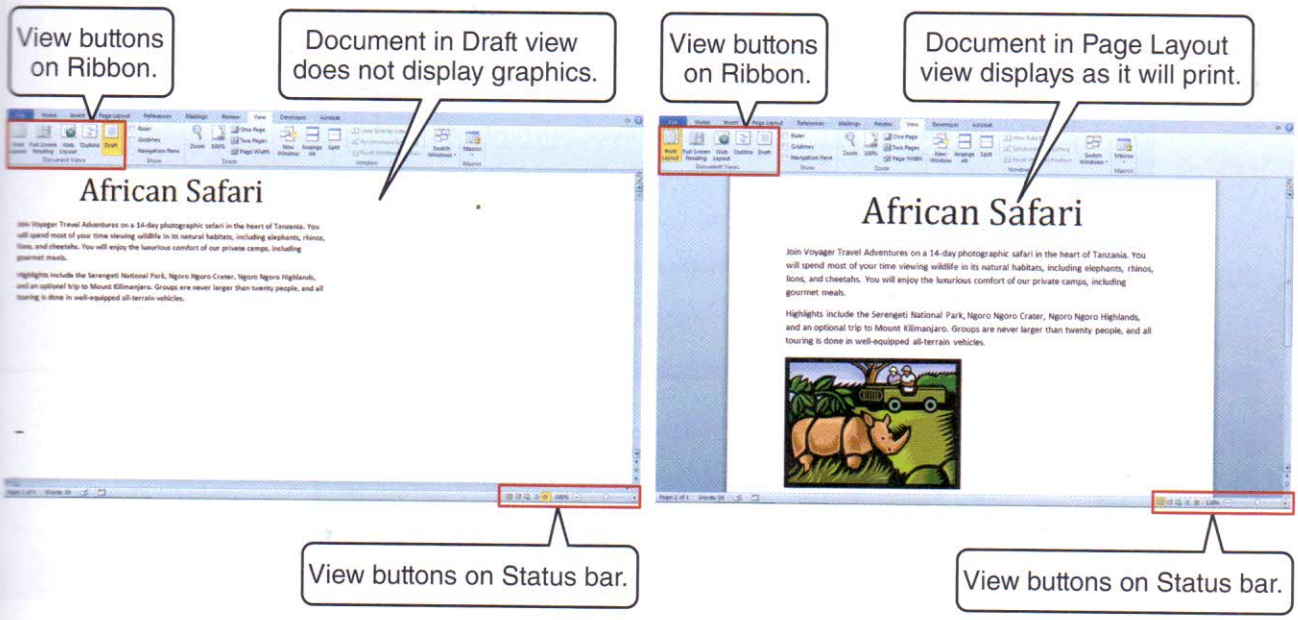


Figure 10.3.2 The same document displayed in Draft view (left) and Page Layout view (right) in Microsoft Office.

Connections

Language Arts Settings in the Proofing section of Microsoft Word's Options can help you check and correct your spelling and grammar as you type. See which options are set as program defaults. Customizing these settings may enable you to write better and more clearly.

Checking Your Status Many software programs display a **status bar** below the application workspace. A status bar shows information about the program and other useful messages. For example, the status bar in Word displays the current page number, total page count, and the number of the line on which you are currently typing.

Setting Options and Preferences

Software applications start using **default** settings. These are options preset by the software maker, based on what most users prefer. You can customize the program for the way you want to work by selecting **preferences** or options. Changing an option or preference replaces the default setting.

You can change such features as how the screen looks, how the spelling checker works, and the preferred location for saving documents. You can choose to apply a preference to a current document only, or save it in the computer as a new default setting. Many programs also allow you to reset the revised default settings back to their original settings. To set options in a Microsoft Office program, click File and then click Options.

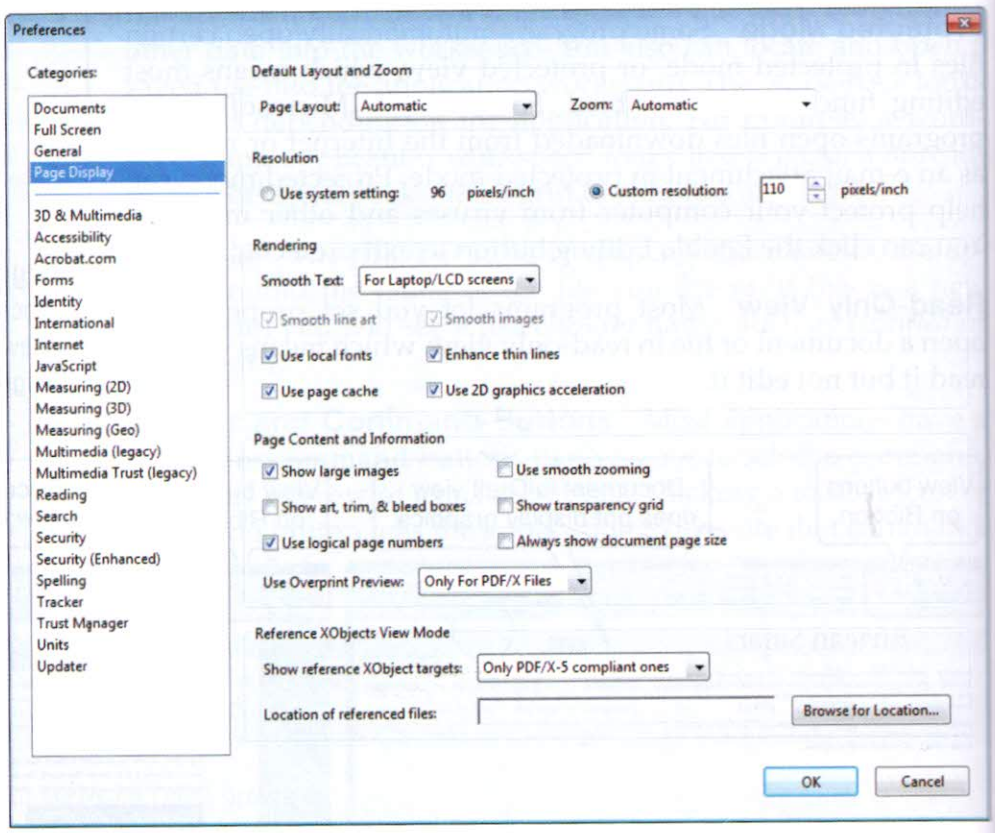


Figure 10.3.3 Changing default Display settings in Adobe Reader.

Common Application Features

Most application programs have many of the same features. For example, most programs include cut, copy, and paste commands for moving and copying text and objects. Text formatting commands are similar in almost all programs, as are commands for inserting, moving, and resizing objects, such as pictures. Most include a spelling checker that you can use to identify and correct spelling errors. Other common features including the Print command for printing a file, Undo and Redo commands for undoing changes, and a Search, or Find and Replace command for locating specific information within the file. Most programs also have a built-in Help program you can use to look up information about how to use the program or to solve problems. Usually, you can press the F1 key or click a Help icon to start Help.

Working with Two or More Programs

The term **multitasking** means working with more than one computer application at the same time. Computer operating systems allow you to multitask by giving sections of memory to each application that is running. You can then switch among them as needed.

To multitask, open the desired programs, such as a word processor and a spreadsheet. Each application appears in a separate window. Select one window by clicking its button on the taskbar, and begin to work. You can move from one window to another. If you create a chart in a spreadsheet, you can cut or copy and paste it into the word processor. When you are done, exit each application to close your programs.

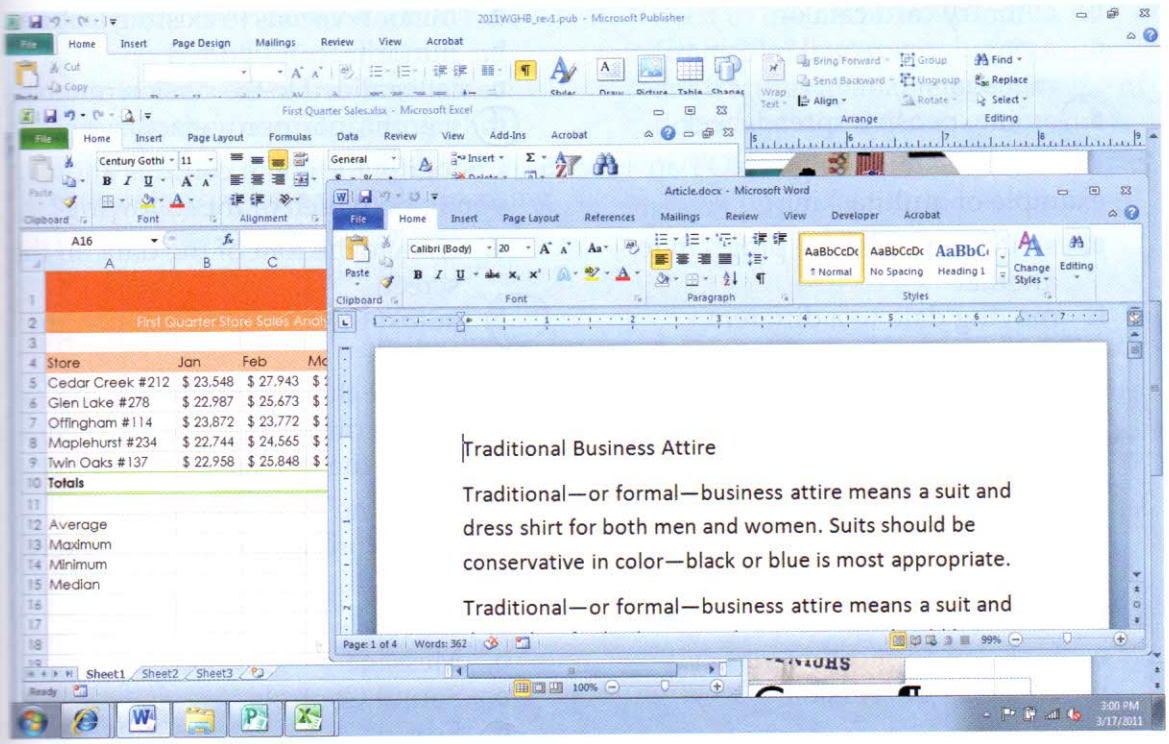


Figure 10.3.4 Multitasking means using more than one program at a time.

Use the Vocabulary

Directions: *Match each vocabulary term in the left column with the correct definition in the right column.*

C 1. vertical application
d 2. horizontal application
h 3. beta version
e 4. copy protection
f 5. documentation
j 6. version
a 7. site license
b 8. application workspace
g 9. zoom
i 10. preference

a. permission to install software on multiple computers
b. main area of a program window
c. a program designed for a limited purpose
d. a general-purpose program that can be used by a variety of users
e. tool that keeps a user from making unauthorized copies of software
f. instructions that make using software easier
g. to change the size of the data on the screen
h. test copy of software that companies use to find errors
i. setting defined by the computer user
j. copy of software that may have new features

Check Your Comprehension

Directions: *Determine the correct choice for each of the following.*

1. Which of the following is an example of a vertical application?
   a. an Internet browser
   b. a library card catalog
   c. a popular personal information manager
   d. an inexpensive spreadsheet
2. Which of the following is NOT an example of multitasking?
   a. switching from one program to another
   b. moving data to a different document
   c. keeping your desktop clear
   d. working in three or four applications at once
3. Software documentation can help you do which of the following?
   a. troubleshoot problems
   b. obtain a site license
   c. make an application vertical
   d. create a new version
4. Which of the following is NOT a characteristic of a maintenance release?
   a. minor revisions to existing features
   b. minor features added
   c. letter added to the version number
   d. significant improvements
5. Changing the zoom controls allows you to do which of the following?
   a. change the font of the data on the screen
   b. adjust the size of the data on the screen
   c. change the order in which the data is displayed on the screen
   d. adjust the document's margins
6. Which of the following menus would a word processor most likely have?
   a. Calculate
   b. Message
   c. Sound Controls
   d. Edit

Think Critically

Directions: *Answer the following questions.*

1. What are some consequences of violating copyright laws to both software companies and to users?

2. In what ways do beta versions help improve new software applications?

3. Why is good documentation important?

4. Why might a user choose to upgrade to a newer version of a particular software application?

5. How are the terms *default* and *preferences* related?

Extend Your Knowledge

Directions: *Choose and complete one of the following projects.*

A. Horizontal applications are popular types of software, such as word processors and Internet browsers, with which most computer users work. Vertical applications are designed for more specific activities. Interview two adults who use computers for their jobs. Identify the types of applications they use at work. What programs do they use that are specific to their careers or businesses? How do they use popular applications differently? For both types of software, to what extent do licensing agreements and customer service/technical support influence their purchasing decisions? Create a Venn diagram comparing your findings.

B. Several types of documentation are listed in this chapter, including printed material, help screens, and Web sites. Using the Internet or other resources, prepare a report that discusses documentation. Discuss the purpose of each type of documentation. How and when might you need to use each—now and in the future? What are some of the different features available in each type of documentation? Share your reports with the class.