

Input and Output



▲ Download the free *Computing Essentials 2014* app for videos, key term flashcards, quizzes, and the game, *Over the Edge!*

Competencies

After you have read this chapter, you should be able to:

- 1 Define input.
- 2 Describe keyboard entry including types and features of keyboards.
- 3 Discuss pointing devices including game controllers and styluses.
- 4 Describe scanning devices including optical scanners, RFID readers, and recognition devices.
- 5 Discuss image capturing and audio-input devices.
- 6 Define output.
- 7 Discuss monitor features and types including flat-panels and e-books.
- 8 Define printing features and types including inkjet and cloud printers.
- 9 Discuss audio and video devices including portable media devices and Mobile DTV.
- 10 Define combination input and output devices including multifunctional devices, Internet telephones, robots, and VR headgear and gloves.
- 11 Discuss ergonomics and ways to minimize physical damage.

Why should I read this chapter?

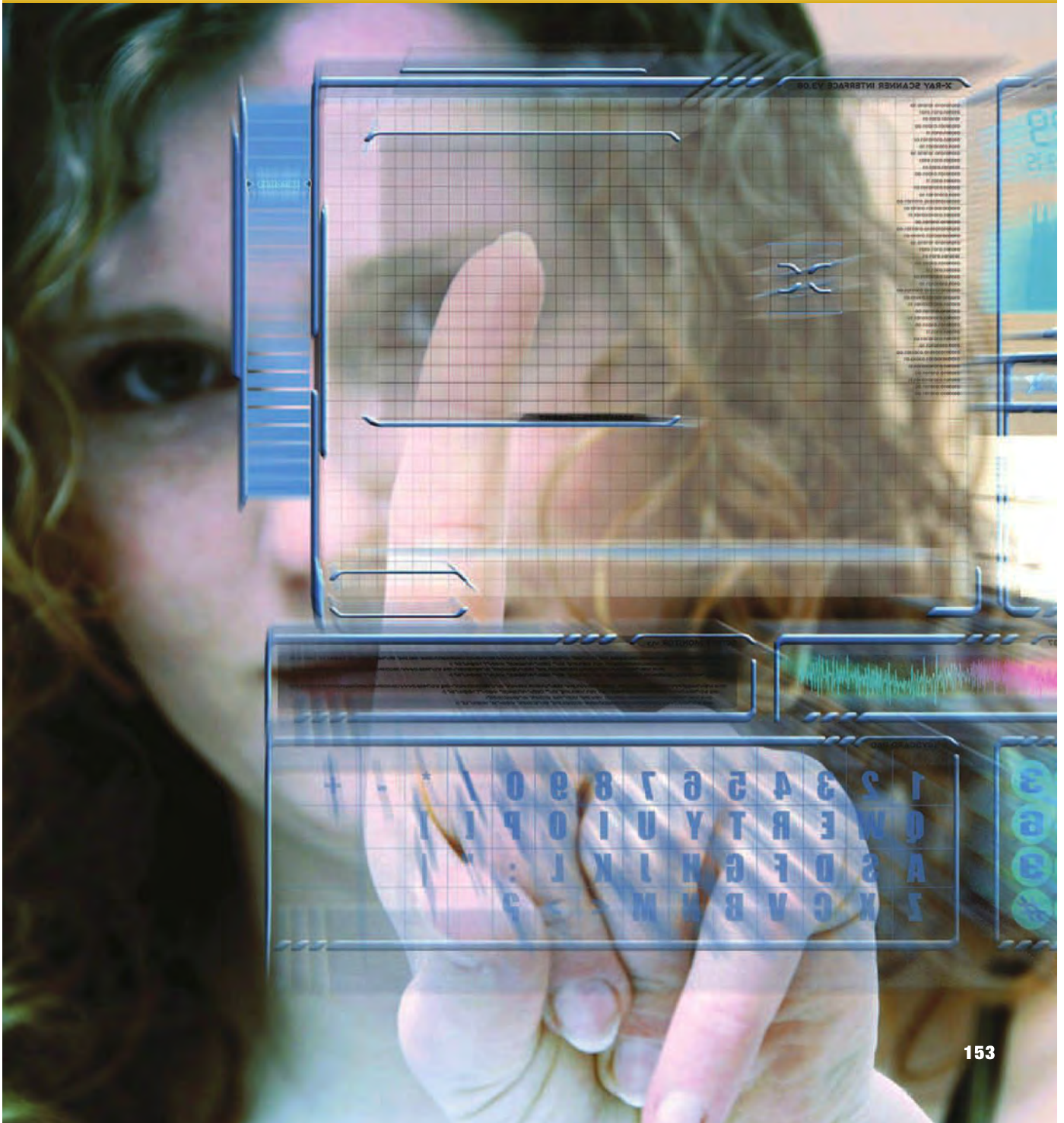
Years ago the only way to interact with a computer was through a keyboard, a monitor, and a printer. That was then and this is now. Now, we can input data in a wide variety of ways including pointing, scanning, and photographing. Computers can provide output in many different ways including humanlike voices, monitors that are almost as thin as a piece of paper, and inexpensive high-speed printers.

This chapter discusses a variety of input devices including

wireless and virtual keyboards, touch screens, digital interactive white boards, portable scanners, webcams, and voice recognition systems. Additionally, you'll learn about output devices including e-book readers, HDTV, cloud printers, photo printers, and portable media players. To be competent and to be competitive in today's professional workplace, you need to know and to understand these things.



chapter 6



Introduction



Hi, I'm Marie, and I'm a technical writer. I'd like to talk with you about input and output devices. . . . all those devices that help us to communicate with a computer. I'd also like to talk about emerging technologies such as robotics and virtual reality.

How do you send instructions and information to the CPU? How do you get information out? Here we describe one of the most important places where computers interface with people. We input text, music, and even speech, but we probably never think about the relationship between what we enter and what the computer processes. People understand language, which is constructed of letters, numbers, and punctuation marks. However, at a basic level, computers can understand only the binary machine language of 0s and 1s. Input devices are essentially translators. Input devices translate numbers, letters, and actions that people understand into a form that computers can process.

Have you ever wondered how information processed by the system unit is converted into a form that you can use? That is the role of output devices. While input devices convert what we understand into what the system unit can process, output devices convert what the system unit has processed into a form that we can understand. Output devices translate machine language into letters, numbers, sounds, and images that people can understand.

Competent end users need to know about the most commonly used input devices, including keyboards, mice, scanners, digital cameras, voice recognition, and audio-input devices. Additionally, they need to know about the most commonly used output devices, including monitors, printers, and audio-output devices. And end users need to be aware of combination input and output devices such as multifunctional devices and Internet telephones.

What Is Input?

Input is any data or instructions that are used by a computer. They can come directly from you or from other sources. You provide input whenever you use system or application programs. For example, when using a word processing program, you enter data in the form of numbers and letters and issue commands such as to save and to print documents. You also can enter data and issue commands by pointing to items or using your voice. Other sources of input include scanned or photographed images.

Input devices are hardware used to translate words, sounds, images, and actions that people understand into a form that the system unit can process. For example, when using a word processor, you typically use a keyboard to enter text and a mouse to issue commands. In addition to keyboards and mice, there are a wide variety of other input devices. These include pointing, scanning, image capturing, and audio-input devices.

Keyboard Entry

One of the most common ways to input data is by **keyboard**. As mentioned in Chapter 5, keyboards convert numbers, letters, and special characters that people understand into electrical signals. These signals are sent to, and processed by, the system unit. Most keyboards use an arrangement of keys



Figure 6-1 Traditional keyboard

given the name QWERTY. This name reflects the keyboard layout by taking the letters of the first six alphabetic characters found on the top row of keys displaying letters.

Keyboards

There are a wide variety of different keyboard designs. They range from the full-sized to miniature and can even be virtual. There are four basic categories of keyboards: traditional, notebook, virtual, and thumb.

- **Traditional keyboards**—these keyboards are widely used on desktops and larger computers. The standard U.S. traditional keyboard has 101 keys. Some traditional keyboards include a few additional special keys. For example, the Windows keyboard includes a key to directly access the Start menu. Traditional keyboards provide function keys, navigation keys, and a numeric keypad. Some keys, such as the Caps Lock key, are **toggle keys**. These keys turn a feature on or off. Others, such as the Ctrl key, are **combination keys**, which perform an action when held down in combination with another key. (See Figure 6-1.)
- **Notebook keyboards**—these keyboards are widely used on notebook computers including netbooks. While the precise location and number of keys may differ among manufactures, notebook keyboards typically have fewer keys, do not include a numeric keypad, and do not have a standard location for the function and navigation keys. (See Figure 6-2 top.)
- **Virtual keyboards**—these keyboards are widely used on tablets and on some smartphones. Unlike other keyboards, virtual keyboards do not have a physical keyboard. Rather, the keys are typically displayed on a screen and selected by touching their image on the screen. (See Figure 6-2 middle.)
- **Thumb keyboards**—these keyboards are widely used on smartphones and other small portable devices. Designed primarily for communicating via texting and connecting to the web, these keyboards are very small. (See Figure 6-2 bottom.)



Notebook keyboard



Virtual keyboard



Thumb keyboard

Figure 6-2 Keyboards



concept check



What is input? What are input devices?



List and compare the four categories of keyboards.



What are toggle keys? What are combination keys?

Pointing Devices

Pointing is one of the most natural of all human gestures. **Pointing devices** provide an intuitive interface with the system unit by accepting pointing gestures and converting them into machine-readable input. There are a wide variety of different pointing devices, including the mouse, joystick, touch screen, and stylus.

Mice

A **mouse** controls a pointer that is displayed on the monitor. The **mouse pointer** usually appears in the shape of an arrow. It frequently changes shape, however, depending on the application. A mouse can have one, two, or more buttons, which are used to select command options and to control the mouse pointer on the monitor. Some mice have a **wheel button** that can be rotated to scroll through information that is displayed on the monitor.

Although there are several different designs, the **optical mouse** is the most widely used. It emits and senses light to detect mouse movement. Traditionally, the detected movements are communicated to the system unit through a cord. Alternatively, the **cordless** or **wireless mouse** uses radio waves or infrared light waves to communicate with the system unit. (See Figure 6-3.) These devices eliminate the mouse cord and free up desk space.

Three devices similar to a mouse are trackballs, touch pads, and pointing sticks.

- **Trackballs** control the pointer by rotating a ball with your thumb. (See Figure 6-4.)



Figure 6-3 Optical mouse



Figure 6-4 Trackball



Figure 6-5 Touch pad



Figure 6-6 Pointing stick

- **Touch pads** control the pointer by moving and tapping your finger on the surface of a pad. (See Figure 6-5.)
- **Pointing sticks**, located in the middle of the keyboard, control the pointer by directing the stick with one finger. (See Figure 6-6.)

Touch Screens

A **touch screen** allows users to select actions or commands by touching the screen with a finger or penlike device. **Multitouch screens** can be touched with more than one finger, which allows for interactions such as rotating graphical objects on the screen with your hand or zooming in and out by pinching and stretching your fingers. Multitouch screens are commonly used with tablets and smartphones, as well as some notebook computers and desktop monitors. (See Figure 6-7.)

Game Controllers

Game controllers are devices that provide input to computer games. While keyboards and mice can be used as game controllers, the four most popular and specialized game controllers are joysticks, dance pads, gamepads, and motion sensing devices. (See Figure 6-8.)

- **Joysticks** control game actions by users varying the pressure, speed, and direction of a control stick.
- **Dance pads** provide input for dance games. Users move (dance) on a pressure-sensitive mat that provides input to the game.
- **Gamepads** are designed to be held by two hands and provide a wide array of inputs including motion, turning, stopping, and firing.
- **Motion-sensing devices** control games by user movements. For example, Microsoft's Kinect motion-sensing device accepts user movements and spoken commands to control games on the Xbox 360.

Stylus

A **stylus** is a penlike device commonly used with tablet PCs and PDAs. (See Figure 6-9.) A stylus uses pressure to draw images on a screen. Often, a stylus interacts with the computer through handwriting recognition software. **Handwriting recognition software** translates handwritten notes into a form that the system unit can process.



Figure 6-7 Multitouch screen



Joystick



Dance pad



Game pad



Motion-sensing device

Figure 6-8 Game controllers



Figure 6-9 Stylus



concept check



What is a pointing device? Describe four pointing devices.

What is an optical mouse? What is a multitouch screen?

Describe four game controllers. What is a stylus?

Scanning Devices

Scanners move across text and images. **Scanning devices** convert scanned text and images into a form that the system unit can process. There are five types of scanning devices: optical scanners, card readers, RFID readers, bar code readers, and character and mark recognition devices.

Optical Scanners

An **optical scanner**, also known simply as a **scanner**, accepts documents consisting of text and/or images and converts them to machine-readable form. These devices

do not recognize individual letters or images. Rather, they recognize light, dark, and colored areas that make up individual letters or images. Typically, scanned documents are saved in files that can be further processed, displayed, printed, or stored for later use. There are three basic types of optical scanners: flatbed, document, and portable.

- **Flatbed scanner** is much like a copy machine. The image to be scanned is placed on a glass surface, and the scanner records the image from below.
- **Document scanner** is similar to a flatbed scanner except that it can quickly scan multipage documents. It automatically feeds one page of a document at a time through a scanning surface. (See Figure 6-10.)
- **Portable scanner** is typically a handheld device that slides across the image, making direct contact.



Figure 6-10 Document scanner

Optical scanners are powerful tools for a wide variety of end users, including graphics and advertising professionals who scan images and combine them with text. Lawyers and students use portable scanners as a valuable research tool to record information.

Card Readers

Nearly everyone uses a credit card, debit card, access (parking or building) card, and/or some type of identification card. These cards typically have the user's name, some type of identification number, and signature on the card. Additionally, encoded information is often stored on the card as well. **Card readers** interpret this encoded information.

Although there are several different types, by far the most common is the **magnetic card reader**. The encoded information is stored on a thin magnetic strip located on the back of the card. When the card is swiped through the magnetic card reader, the information is read.

Bar Code Readers

You are probably familiar with **bar code readers** or **scanners** from grocery stores. These devices are either handheld **wand readers** or **platform scanners**. They contain photoelectric cells that scan or read **bar codes**, or the vertical zebra-striped marks printed on product containers.

Almost all supermarkets use electronic cash registers and a bar code system called the **Universal Product Code (UPC)**. At the checkout counter, electronic cash registers use a bar code reader to scan each product's UPC code. The codes are sent to the supermarket's computer, which has a description, the latest price, and an inventory level for each product. The computer processes this input to update the inventory level and to provide the electronic cash register with the description and price for each product. These devices are so easy to use that many supermarkets are offering customers self-checkout stations.

Smartphones can also scan bar codes. (See Figure 6-11.) With the appropriate app, you can scan the bar code of a product and get comparative prices. For example, after scanning the bar code from a product you are thinking of buying, the app Price Check by Amazon will provide in-store and online price comparisons as well as provide other customer product reviews.



Figure 6-11 Smartphone bar code reader

RFID Readers

RFID (radio-frequency identification) tags are tiny chips that can be embedded in most everything. They can be found in consumer products, driver's licenses, passports, and any number of other items. These chips contain electronically



Figure 6-12 RFID reader



Figure 6-13 Wand reader

stored information that can be read using an **RFID reader** located several yards away. (See Figure 6-12.) They are widely used to track and locate lost pets; to monitor production and update inventory; and to record prices, product descriptions, and locations of retail items.

Some argue that these tags may one day be inserted into humans to track their locations. Even if the tabs are not embedded into humans, they will likely be embedded into the clothes worn by humans. They argue that RFID tags are a serious threat to our privacy and their use needs to be carefully controlled by legislation.

Character and Mark Recognition Devices

Character and mark recognition devices are scanners that are able to recognize special characters and marks. They are specialty devices that are essential tools for certain applications. Three types are

- **Magnetic-ink character recognition (MICR)**—used by banks to automatically read those unusual numbers on the bottom of checks and deposit slips. A special-purpose machine known as a reader/sorter reads these numbers and provides input that allows banks to efficiently maintain customer account balances.
- **Optical-character recognition (OCR)**—uses special preprinted characters that can be read by a light source and changed into machine-readable code. A common OCR device is the handheld wand reader. (See Figure 6-13.) These are used in department stores to read retail price tags by reflecting light on the printed characters.
- **Optical-mark recognition (OMR)**—senses the presence or absence of a mark, such as a pencil mark. OMR is often used to score standardized multiple-choice tests.



concept check

- What is a scanner?
- Describe five types of scanning devices.
- Describe three common character and mark recognition devices.

Image Capturing Devices

Optical scanners, like traditional copy machines, can make a copy from an original. For example, an optical scanner can make a digital copy of a photograph. *Image capturing devices*, on the other hand, create or capture original images. These devices include digital cameras and **digital video cameras**.

Digital Cameras

Digital cameras are similar to traditional cameras except that images are recorded digitally on a disk or in the camera's memory. Most digital cameras



Figure 6-14 Digital camera



Figure 6-15 Attached webcam

are also able to record video as well. (See Figure 6-14.) Almost all tablets and smartphones have built-in digital cameras capable of taking images and video. You can take a picture, view it immediately, and even place it on your own web page, within minutes.

To learn more about how digital photography works, visit us on the web at www.computing2014.com and enter the keyword **photo**. Digital photographs can be shared easily with others over the Internet.

Webcams

Webcams are specialized digital video cameras that capture images and send them to a computer for broadcast over the Internet. Webcams are built into most smartphones and tablets. Desktop and notebook webcams are either built in or attached to the computer's monitor. (See Figure 6-15.) To learn more about webcams, visit our website at www.computing2014.com and enter the keyword **webcam**.

Audio-Input Devices

Audio-input devices convert sounds into a form that can be processed by the system unit. By far the most widely used audio-input device is the microphone. Audio input can take many forms, including the human voice and music.

Voice Recognition Systems

Voice recognition systems use a microphone, a sound card, and special software. These systems allow users to operate computers and other devices as well as to create documents using voice commands. Examples include voice-controlled dialing features on mobile phones,

ethics

You may have heard of instances where webcams were used to broadcast the activities of individuals who did not know they were being recorded. For example, in a famous court case, a university student was prosecuted for using a webcam on an open laptop to secretly record his roommate's intimate activities. In other situations, public webcams have recorded embarrassing footage of people who were not aware of the camera. It has been argued that capturing and then broadcasting a person's image without his or her knowledge and consent is unethical. What do you think? To see other ethical issues, visit our website at www.computing2014.com and enter the keyword **ethics**.

Have you ever had trouble communicating with someone who does not speak English? If so, Google Translate may be just what you need.

tips

- 1 Go to translate.google.com.
- 2 Using the buttons at the top, select the language you will be speaking, followed by the language you want your words translated to.
- 3 Click the microphone icon in the box on the left, and begin speaking clearly into your microphone. In a few seconds, you will see the translated text in the box on the right.
- 4 Click the speaker icon in the box on the right to hear the translation.

If you own a smartphone, consider installing the free Google Translate app. To see other tips, visit our website at www.computing2014.com and enter the keyword **tips**.



Figure 6-16 Voice recorders

navigation on GPS devices, and control of car audio systems. Specialized portable voice recorders are widely used by doctors, lawyers, and others to record dictation. (See Figure 6-16.) These devices are able to record for several hours before connecting to a computer system to edit, store, and print the dictated information. Some systems are even able to translate dictation from one language to another, such as from English to Japanese.



concept check



How are digital cameras different from traditional cameras?

What is a webcam? Describe the two basic designs.

What are voice recognition systems?

What Is Output?

Output is processed data or information. Output typically takes the form of text, graphics, photos, audio, and/or video. For example, when you create a presentation using a presentation graphics program, you typically input text and graphics. You also could include photographs and even add voice narration. The output would be the completed presentation.

Output devices are any hardware used to provide or to create output. They translate information that has been processed by the system unit into a form that humans can understand. There are a wide range of output devices. The most widely used are monitors, printers, and audio-output devices.



Figure 6-17 Monitor resolution

Monitors

The most frequently used output device is the **monitor**. Also known as **display screens**, monitors present visual images of text and graphics. The output is often referred to as **soft copy**. Monitors vary in size, shape, and cost. Almost all, however, have some basic distinguishing features.

Features

The most important characteristic of a monitor is its clarity. **Clarity** refers to the quality and sharpness of the displayed images. It is a function of several monitor features, including resolution, dot pitch, contrast ratio, size, and aspect ratio.

- **Resolution** is one of the most important features. Images are formed on a monitor by a series of dots or **pixels (picture elements)**. (See Figure 6-17.) Resolution is expressed as a matrix of these dots or pixels. For example, many monitors today have a resolution of 1,600 pixel columns by 1,200 pixel rows for a total of 1,920,000 pixels. The higher a monitor's resolution (the more pixels), the clearer the image produced. See Figure 6-18 for the most common monitor resolutions.

Standard	Pixels
UXGA	1,600 × 1,200
QXGA	2,048 × 1,536
WQXGA	2,560 × 1,600
QXSGA	2,560 × 2,048
QWXGA+	2,880 × 1,800

Figure 6-18 Resolution standards

- **Dot (pixel) pitch** is the distance between each pixel. Most newer monitors have a dot pitch of 0.31 mm (31/100th of a millimeter) or less. The lower the dot pitch (the shorter the distance between pixels), the clearer the images produced.
- **Contrast ratios** indicate a monitor's ability to display colors. It compares the light intensity of the brightest white to the darkest black. The higher the ratio, the better the monitor. Good monitors typically have contrast ratios between 500:1 and 2000:1.
- **Size, or active display area**, is measured by the diagonal length of a monitor's viewing area. Common sizes are 15, 17, 19, 21, and 24 inches.
- **Aspect ratio** is determined by the width of a monitor divided by its height. The most common aspect ratio for standard monitors (similar to traditional television pictures) is 4:3. The most common aspect ratios for wide-screen monitors are 16:9 and 16:10.



Figure 6-19 Flat-panel monitor

Flat-Panel Monitors

Flat-panel monitors are the most widely used type of monitor today. Compared to other types, they are thinner, are more portable, and require less power to operate. (See Figure 6-19.)

Most of today's flat-panel monitors are **LCD (liquid crystal display)**. One characteristic of LCD technology is that the monitors are backlit, meaning that a common source of light is dispersed over all the pixels on the screen. Although there are many variations of LCD displays, the most common for today's monitors is the **TFT-LC (thin-film transistor liquid crystal)** in which each pixel is independently activated, producing a high-quality and energy-efficient image. **AMOLED (active-matrix organic light-emitting diode)** is a newer technology and is becoming widely used. Compared to LCD, AMOLED technology has the benefits of lower power consumption and longer battery life, as well as possibilities for much thinner displays.

Explorations



AMOLED is just one type of LED (light-emitting diode).

To learn more about various LED technologies for monitors and TVs, visit our website at www.computing2014.com and enter the keyword **led**.

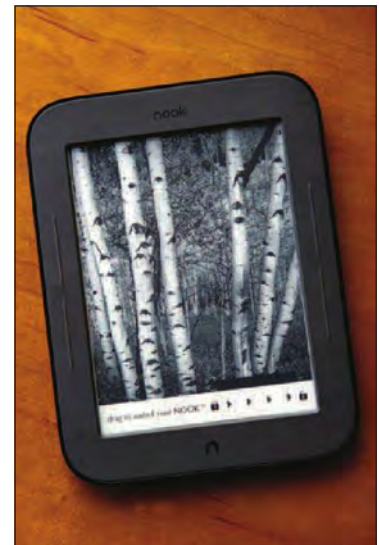
E-book Readers

E-books (electronic books) are traditional printed books in electronic format. These books are available from numerous sources including many public and private libraries, bookstore websites, and the cloud. **E-book readers (e-readers)** are dedicated mobile devices for storing and displaying e-books and other electronic media including electronic newspapers and magazines.

E-book readers have displays that are typically 6 inches, are limited to black and white output, and use a technology known as **e-ink**. **E-ink** produces images that reflect light like ordinary paper, making the display easy to read. Two well-known e-book readers are Amazon's Kindle and Barnes & Noble's Nook Simple Touch. (See Figure 6-20.)

Tablets can also display e-books. They are larger, heavier, and more expensive than e-book readers. They are also much more flexible, with displaying e-books being only one of their any number of applications. Unlike dedicated e-book readers, these tablets use LCD displays that provide crisp, colorful images, however, that are difficult to read in bright light due to their reflective nature. Two well-known traditional tablets are Apple's iPad and Samsung's Galaxy Tab.

To learn more about e-books, see Making IT Work for You: E-books, on page 164.



Dedicated e-book reader

Figure 6-20 E-book reader

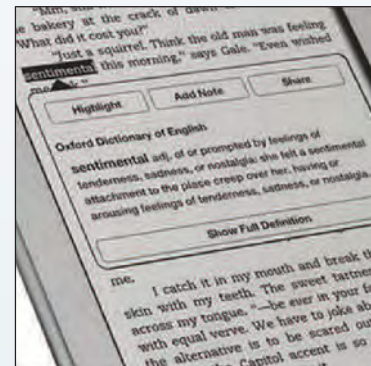
Making IT work for you

E-BOOKS

Are you tired of carrying a book bag filled with textbooks? Have you ever wished you could have a reference book or text at your fingertips, instead of at home on a bookshelf? E-books are the solutions to these problems, and this guide will discuss their benefits, as well as various options on how to access and read them.

Benefits of E-books Because e-books are digital, they offer a wide range of benefits:

1. **Transporting.** Books can take up a large volume of space in any home (or your school bag). With e-books, you can store over a thousand books in one small device!
2. **Searching.** Type any keyword, and you will be taken to the page(s) where that word appears. This is much faster than using an index.
3. **Bookmarking.** Mark any number of pages as important. This is an improvement over having countless physical bookmarks or folded pages.
4. **Adding highlights and notes.** All marks on an e-book are digital. They can be added and removed easily. The same could not be said for physical textbooks.
5. **Purchasing.** Buying an e-book can take less than a minute, as it is downloaded instantly to your device. Prices also tend to be lower than those for physical books.



Reading E-books Once you decide to purchase an e-book, you may be surprised by the number of devices you can use to read it.

1. **E-book reader.** Dedicated e-book readers, such as the Amazon Kindle and the Barnes & Noble Nook, can be purchased for less than \$100. If it is important for you to read in direct sunlight or areas with heavy lighting, the e-ink used by these devices will be desirable.
2. **Smartphones and tablets.** Do you already own a smartphone or tablet that you take everywhere? If so, you may want to download the free apps from e-book sellers to avoid the cost of a separate e-book reader. The reading experience on these apps is excellent with the touch-screen interface present in these devices.
3. **Notebook and desktop computers.** Although many e-book retailers make apps for your computer, sellers such as Google allow you to read books purchased from its Google Play store with nothing more than a web browser.



Most e-book sellers offer the synchronization of your e-books and notes with their cloud services. This allows you to start reading a book using your tablet, for example, and pick up where you left off with your smartphone.

The web is continually changing, and some of the specifics presented in this Making IT Work for You may have changed.

To learn about other ways to make information technology work for you, visit our website at www.computing2014.com and enter the keyword [miw](#).



Figure 6-21 Digital whiteboard



Figure 6-22 3-D HDTV

Other Monitors

There are several other types of monitors. Some are used for more specialized applications, such as making presentations and watching television.

- **Digital or interactive whiteboards** are specialized devices with a large display connected to a computer or projector. The computer's desktop is displayed on the digital whiteboard and controlled using a special pen, a finger, or some other device. Digital whiteboards are widely used in classrooms and corporate boardrooms. (See Figure 6-21.)
- **High-definition television (HDTV)** delivers a much clearer and more detailed wide-screen picture than regular television. Because the output is digital, users can readily freeze video sequences to create high-quality still images. The video and still images can then be digitized, edited, and stored on disk for later use. This technology is very useful to graphic artists, designers, and publishers. One the most recent and dramatic advances is 3-D HDTV. (See Figure 6-22.) Using special viewing glasses, 3-D HDTV provides theater-quality three-dimensional viewing.
- **Cathode-ray tubes (CRTs)** are similar in size and technology to older televisions. They have been replaced by flat-panel monitors. Discarded CRTs, however, are a serious threat to our environment. Each color CRT contains approximately four pounds of lead and numerous other hazardous materials. Don't just throw out an obsolete CRT. Dispose of it in a responsible manner through an EPA-certified recycling program. Most large cities and manufacturers including IBM, Microsoft, and Dell have certified programs.



concept check



What is output? What are output devices?

Define these monitor features: resolution, contrast ratios, refresh rate, size, and aspect ratio.

Describe flat-panel, CRT, and other more specialized monitors.

Printers

Even as many individuals, schools, and businesses are trying to go paperless, printers remain one of the most used output devices. You probably use a printer to print homework assignments, photographs, and web pages. **Printers** translate information that has been processed by the system unit and present the information on paper. Printer output is often called **hard copy**.

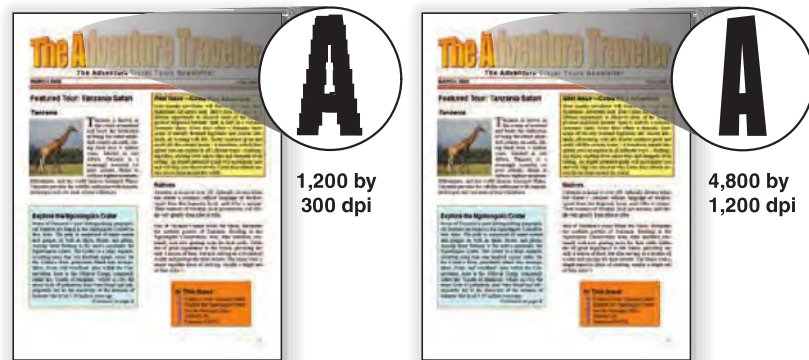


Figure 6-23 DPI comparison

environment

Have you considered the environmental impact of using your inkjet printer? Whenever possible, don't print. Use e-mail attachments, and encourage your school to use web technologies that let students upload their schoolwork. If you must print, buy ink cartridges that are made with mostly recycled plastic. And when your ink runs out, bring the cartridge to a retailer that will make sure it is recycled. Many retailers often offer a discount on a new cartridge when you turn in an empty one. To see more environmental facts, visit our website at www.computing2014.com and enter the keyword [environment](#).

Features

There are many different types of printers. Almost all, however, have some basic distinguishing features, including resolution, color capability, speed, memory, and duplex printing.

- **Resolution** for a printer is similar to monitor resolution. It is a measure of the clarity of images produced. Printer resolution, however, is measured in **dpi (dots per inch)**. (See Figure 6-23.) Most printers designed for personal use average 4,800 by 1,200 dpi. The higher the dpi, the better the quality of images produced.
- **Color capability** is provided by most printers today. Users typically have the option to print either with just black ink or with color. Because it is more expensive to print in color, most users select black ink for letters, drafts, and homework. The most common black ink selection is **grayscale**, in which images are displayed using many shades of gray. Color is used more selectively for final reports containing graphics and for photographs.
- **Speed** is measured in the number of pages printed per minute. Typically, printers for personal use average 15 to 19 pages per minute for single-color (black) output and 13 to 15 pages per minute for color output.
- **Memory** within a printer is used to store printing instructions and documents waiting to be printed. The more memory in a printer, the faster it will be able to create large documents.
- **Duplex printing** allows automatic printing on both sides of a sheet of paper. Although not currently a standard feature for all printers, it will likely become standard in the future as a way to reduce paper waste and to protect the environment.



Figure 6-24 Inkjet printer

Inkjet Printers

Inkjet printers spray ink at high speed onto the surface of paper. This process not only produces a letter-quality image but also permits printing to be done in a variety of colors, making it ideal for printing photos. (See Figure 6-24.) Inkjet printers are the most widely used printers. They are reliable, quiet, and relatively inexpensive. The most costly aspect of inkjet printers is replacing the ink cartridges. For this reason, most users specify black ink for the majority of print jobs and use the more

expensive color printing for select applications. Typical inkjet printers produce 17 to 19 pages per minute of black-only output and 13 to 15 pages of color output.

Laser Printers

The **laser printer** uses a technology similar to that used in a photocopying machine. Laser printers use a laser light beam to produce images with excellent letter and graphics quality. More expensive than inkjet printers, laser printers are faster and are used in applications requiring high-quality output. (See Figure 6-25.)

There are two categories of laser printers. **Personal laser printers** are less expensive and are used by many single users. They typically can print 15 to 17 pages a minute. **Shared laser printers** typically support color, are more expensive, and are used (shared) by a group of users. Shared laser printers typically print over 50 pages a minute.

Other Printers

There are several other types of printers. These printers include cloud printers, thermal printers, and plotters:

- **Cloud printers** are printers connected to the Internet that provide printing services to others on the Internet. **Google Cloud Print** is a service that supports cloud printing. Once a user activates a printer using the Google Chrome OS, the user can access that printer anywhere with an Internet connection.
- **Thermal printers** use heat elements to produce images on heat-sensitive paper. These printers are widely used with ATMs and gasoline pumps to print receipts.
- **Plotters** are special-purpose printers for producing a wide range of specialized output. Using output from graphics tablets and other graphical input devices, plotters create maps, images, and architectural and engineering drawings. Plotters are typically used by graphic artists, engineers, and architects to print out designs, sketches, and drawings.



Figure 6-25 Laser printer

When you print a web page, would you like to eliminate the advertisements? Would you like to avoid using excessive ink or paper? Here are a few suggestions:

tips

- 1 **Preview.** Before printing a page, preview the printout and identify exactly what you need to print.
- 2 **Print range.** The *Print* dialog box will allow you to type in the range of pages that you want to print, so that you do not waste paper or ink on unnecessary content.
- 3 **Print selection.** Browsers allow you to highlight the text you want on a web page and then print only that specific selection. You will find the *Selection* option in the *Print* dialog box.
- 4 **Choose printer friendly.** Many web pages have a special *Print* or *Printer Friendly* button/link that formats the page for printers, removing all the ads and sidebars.
- 5 **Print quality.** The *Preferences* button in the *Print* dialog box will allow you to configure the settings of your printer. Use a low-quality (or draft) setting for printouts that you do not plan to turn in for class or work. You will save lots of ink using this process whenever possible.

To see other tips, visit our website at www.computing2014.com and enter the keyword **tips**.



concept check



- Discuss these printer features: resolution, color capability, speed, memory, and duplex printing.
- Compare inkjet printers and laser printers.
- Discuss cloud, thermal, and plotter printers.



Figure 6-26 Headset



Figure 6-27 Digital media player

Audio and Video Devices

Audio-output devices translate audio information from the computer into sounds that people can understand. The most widely used audio-output devices are **speakers** and **headsets**. (See Figure 6-26.) These devices are connected to an audio jack on the system unit. The sound card is used to capture as well as play back recorded sounds. Audio-output devices are used to play music, vocalize translations from one language to another, and communicate information from the computer system to users.

Creating voice output is not anywhere near as difficult as recognizing and interpreting voice input. In fact, voice output is quite common. It is used with many soft-drink machines, telephones, and cars. It is used as a reinforcement tool for learning, such as to help students study a foreign language. It also is used in many supermarkets at the checkout counter to confirm purchases. One of its most powerful capabilities is to assist the physically challenged.

Portable Media Players

Portable media players, also known as digital media players, are electronic devices for storing and playing digital media. Some of the best-known specialized audio and video players are the Apple iPod, Creative Zen, and Microsoft Zune. (See Figure 6-27.)

One of the most recent applications for portable media players is to watch live TV. This is possible through **mobile digital television (mobile DTV)** technology, which allows television stations to broadcast their programming directly to smartphones, computers, and **digital media players**. Now, many people use their smartphones to provide the functionality of dedicated portable media players.

Combination Input and Output Devices

Many devices combine input and output capabilities. Sometimes this is done to save space. Other times it is done for very specialized applications. Common combination devices include multifunctional devices, Internet telephones, and robots.

Multifunctional Devices

Multifunctional devices (MFD) typically combine the capabilities of a scanner, printer, fax, and copy machine. These multifunctional devices offer a cost and space advantage. They cost about the same as a good printer or copy machine but require much less space than the single-function devices they replace. Their disadvantage is that the quality and functionality are not quite as good as those of the separate single-purpose devices. Even so, multifunctional devices are widely used in home and small business offices.

Internet Telephones

Internet telephones are specialized input and output devices for receiving and sending voice communication. (See Figure 6-28.)

Voice over IP (VoIP) is the transmission of telephone calls over computer networks. Also known as **telephony**, **Internet telephony**, and **IP telephony**, VoIP uses the Internet rather than traditional communication lines to support voice communication. To place telephone calls using Internet telephony requires a high-speed Internet connection and a service provider. Many cable service providers offer bundles including Internet, telephone, and television. While these bundles offer a price break, there are other lower-cost options for VoIP from a variety of providers including Ooma, Vonage, MagicJack, and Skype.

Skype provides audio and video service that does not require any dedicated hardware. Once you subscribe to this free service, you can use your computer's existing audio and video devices to connect to any other Skype subscribers. The advantages compared to the other providers are that Skype is free for domestic calls (as well as for international calls), supports video as well as audio, and does not require any special equipment. The disadvantages include that both parties must have their computers on to make or receive calls; calls can only be made between Skype subscribers, although, for an additional fee, you can place calls to non-Skype subscribers; and voice quality and reliability are not as good as traditional telephone communication. To learn more about using Skype, see *Making IT Work for You: Skype*, on pages 170 and 171.

Robots

Artificial intelligence (AI) is a field of computer science that attempts to develop computer systems that can mimic or simulate human senses, thought processes, and actions. **Robotics** is an area of AI concerned with developing and using robots. **Robots** are computer-controlled machines that mimic the motor activities of living things. For example, Honda's ASIMO robot resembles a human and is capable of walking upstairs, dancing, shaking hands, playing musical instruments, and much more. (See Figure 6-29.) Robots are used for a wide variety of applications ranging from domestic to manufacturing to military operations. There are four types of robots.

- **Perception system robots** imitate some of the human senses. For example, robots with television-camera vision systems are particularly useful. They can guide machine tools, inspect products, and secure homes.
- **Industrial robots** are used to perform a variety of tasks. For example, in automotive plants, robots are widely used for welding, polishing, and painting.
- **Mobile robots** act as transports and are widely used for a variety of different tasks. For example, the police and military use them to locate and disarm explosive devices.
- **Household robots** are now widely available and are designed to vacuum or scrub floors, mow lawns, patrol the house, or simply provide entertainment.



Figure 6-28 Internet telephone

environment

Did you know that robots are already being used to help the environment? The U.S. Department of Energy is using a robotic arm to help clean nuclear waste in a large underground facility. Researchers in Europe are currently testing a robotic fish that will swim around various bodies of water in order to detect polluted areas. In the future, robots will continue to help us detect and clean up pollution, especially in areas where toxins are harmful to humans. To see more environmental facts, visit our website at www.computing2014.com and enter the keyword **environment**.

Explorations



There are many humanlike robots being developed for research and education.

To learn more about one of these robots, visit our website at www.computing2014.com and enter the keyword **robot**.

Making IT work for you

SKYPE

Do you already use a communication tool that lets you keep in touch with your friends and family? Does that tool include the ability to have face-to-face conversations, share files and screens, and make calls to those not connected to the Internet? Skype is a well-known tool that offers all these services, most of them for free. This section will help you explore some of Skype's features.

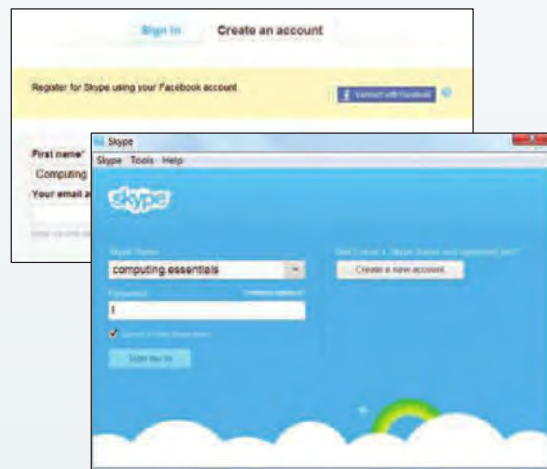
Getting Started In order to enjoy all the benefits of Skype, it is recommended that your computer have speakers, a microphone, and a webcam. If you have a notebook or tablet, these are all likely integrated. Follow these steps to create your account and install Skype on your machine:

- 1 • Visit www.skype.com, and click the **Join Skype** button at the top right.
- 2 • Enter the required information to create your Skype account. When you are finished, the software will be downloaded automatically. Do not purchase any Skype credits at the moment.
- 3 • Run the downloaded setup file, and follow the prompts to install Skype on your machine.
- 4 • Log in to your Skype account on the welcome screen, and follow the prompts to make sure your audio and video are working.

Adding Contacts You can find friends or other contacts manually, or you can import them from your address book on Facebook, Outlook, and several other services. To add a contact manually:

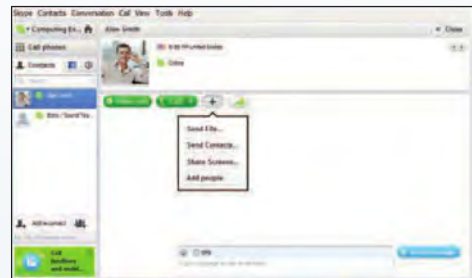
- 1 • Click **Add a Contact** at the bottom of the Contacts List on the left side.
- 2 • Enter the information you know about your contact, such as his or her e-mail address.
- 3 • Skype will display matches. Click the one that matches your contact's details, and then click the **Add** button.

Your contact must accept your request before you can see his or her online status.



Skype-to-Skype Communication When two individuals have Skype accounts, they can contact each other (for free) using a variety of methods, from voice or video calls to instant messages. They can exchange files and share screens with each other. Please note that for videoconferencing between three or more people, you must have a premium or business account.

- 1 • Click the contact you wish to communicate with.
- 2 • Click the *Video Call* or *Call* button. Once your contact accepts the call, your interface will change.
- 3 • During the call, you have the ability to send instant messages and turn audio and/or video on or off by clicking the buttons at the bottom.
- 4 • To send files or share screens, click the *Plus (+)* button at the bottom. You could also have initiated the *Send File* feature from the contact screen without having to place a call.
- 5 • To hang up, press the red *End call* button at the bottom.

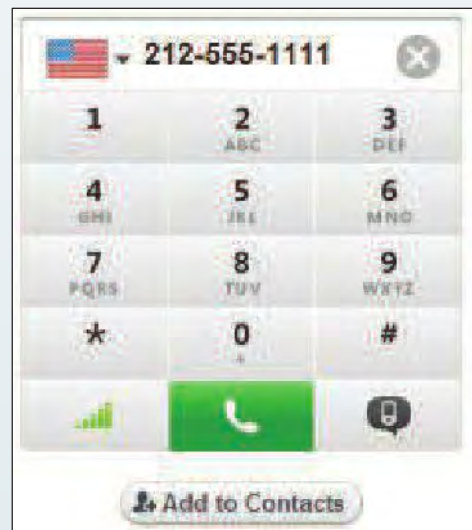


Calling Landline or Mobile Phones (VoIP) Skype can use your Internet connection to place a call to any phone in the world. This is not a free service, but the costs are low. You can pay as you go with Skype credits, or sign up for a monthly subscription.

- 1 • Click the *Call* menu and select *Call Phones*.
- 2 • Click the green *Call* button after entering the phone number.

The web is continually changing, and some of the specifics presented in this Making IT Work for You may have changed.

To learn about other ways to make information technology work for you, visit our website at www.computing2014.com and enter the keyword [miw](#).



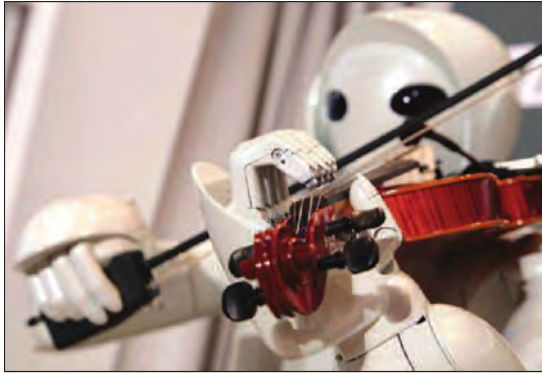


Figure 6-29 ASIMO Robot



Figure 6-30 Virtual reality

ethics

New advances in virtual reality computer software can take us to simulated worlds that allow us to participate in potentially unethical situations that we would probably not do in the real world. Some people worry that spending extended time in a virtual reality environment can be harmful, even dangerous. For example, if participants choose to live in a violent interactive game world, will the virtual experience engage them so much that it dehumanizes them and makes them unable to cope with the laws of the real world? What do you think? To see more ethical issues, visit our website at www.computing2014.com and enter the keyword [ethics](#).

Virtual Reality Headgear and Gloves

Virtual reality (VR) is an artificial, or simulated, reality created in 3-D by computers. It strives to create a virtual or **immersive experience** by using specialized hardware that includes headgear and gloves. (See Figure 6-30.)

The **headgear** has earphones and three-dimensional stereoscopic screens. The **gloves** have sensors that collect data about your hand movements. Coupled with software, this interactive sensory equipment lets you immerse yourself in a computer-generated world.

There are any number of possible applications for virtual reality headgear and gloves. The ultimate recreational use might be something resembling a giant virtual amusement park. More serious applications can simulate important experiences or training environments, such as in aviation, surgical operations, spaceship repair, or nuclear disaster cleanup.



concept check



What are the two most widely used audio-output devices? What is a portable media player? What is mobile digital television?



What are multifunctional devices? Internet telephones? VoIP?



What is artificial intelligence? Robotics? Virtual reality? Headgear? Gloves?

Ergonomics

People use computers to enrich their personal and private lives. There are ways, however, that computers can make people less productive and even harm their health. Anyone who frequently uses a computer can be affected. As a result, there has been great interest in a field known as ergonomics.

Ergonomics (pronounced “er-guh-nom-ix”) is defined as the study of human factors related to things people use. It is concerned with fitting the task to the user rather than forcing the user to contort to do the task. For computer users and manufacturers this means designing input and output devices to increase ease of use and to avoid health risks.

Sitting in front of a screen in awkward positions for long periods may lead to physical problems such as eyestrain, headaches, and back pain. Computer users can alleviate these problems by taking frequent rest breaks and by using

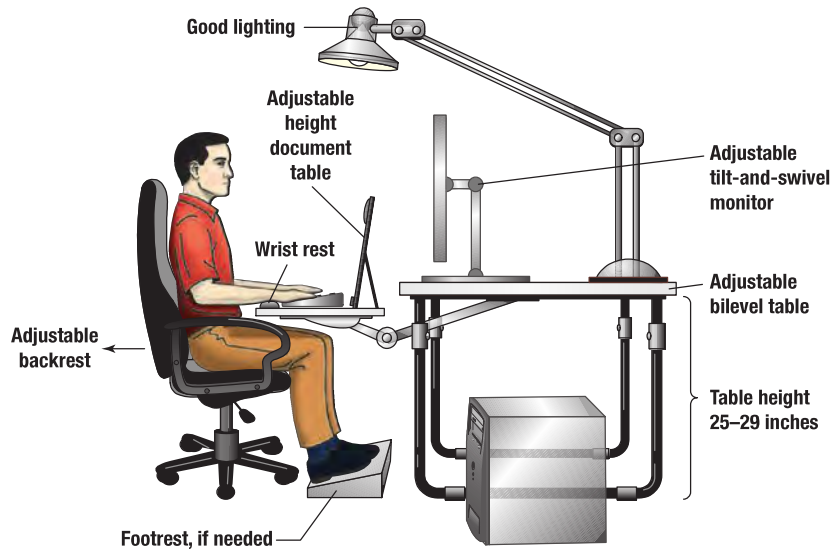


Figure 6-31 Ergonomic recommendations

well-designed computer furniture. Some recommendations by ergonomics experts are illustrated in Figure 6-31.

Other recommendations to avoid physical discomfort are

- **Eyestrain and headache:** To make the computer easier on the eyes, take a 15-minute break every hour or two. Keep everything you're focusing on at about the same distance. For example, the computer screen, keyboard, and a document holder containing your work might be positioned about 20 inches away. Clean the screen of dust from time to time.
- **Back and neck pain:** To help avoid back and neck problems, make sure your equipment is adjustable. You should be able to adjust your chair for height and angle, and the chair should have good back support. The monitor should be at eye level or slightly below eye level. Use a footrest, if necessary, to reduce leg fatigue.
- **Repetitive strain injury: Repetitive strain injury (RSI)** is any injury that is caused by fast, repetitive work that can generate neck, wrist, hand, and arm pain. RSI is by far the greatest cause of workplace illnesses, resulting in compensation claims totaling billions of dollars and lost productivity every year. One particular type of RSI, **carpal tunnel syndrome**, found among heavy computer users, consists of damage to nerves and tendons in the hands. Some victims report the pain is so intense that they cannot open doors or shake hands and that they require corrective surgery. Ergonomically correct keyboards have been developed to help prevent injury from heavy computer use. (See Figure 6-32.) In addition to using ergonomic keyboards, you should take frequent short rest breaks and gently massage your hands.



Figure 6-32 Ergonomic keyboard



concept check



What is ergonomics? How does it relate to input and output devices?



What can be done to minimize eyestrain, headache, back pain, and neck pain?



What is RSI? What is carpal tunnel syndrome?

Careers in IT

Technical writers prepare instruction manuals, technical reports, and other scientific or technical documents. Most technical writers work for computer software firms, government agencies, or research institutions. They translate technical information into easily understandable instructions or summaries. As new technology continues to develop and expand, the need for technical writers who can communicate technical expertise to others is expected to increase.

Technical writing positions typically require an associate or a college degree in communications, journalism, or English and a specialization in, or familiarity with, a technical field. However, individuals with strong writing skills sometimes transfer from jobs in the sciences to positions in technical writing.

Technical writers can expect to earn an annual salary in the range of \$41,000 to \$78,000. Advancement opportunities can be limited within a firm or company, but there are additional opportunities in consulting. To learn about other careers in information technology, visit us at www.computing2014.com and enter the keyword **careers**.



Now that you've learned about input and output devices, I'd like to tell you about my career as a technical writer.

A LOOK TO THE FUTURE

Augmented Reality Displays

Have you ever run into someone who looks familiar, but you cannot remember her name or where you know her from? What about finding yourself in an unfamiliar town, constantly having to look at your smartphone or GPS to get directions? Don't you wish the information would appear instantly, right before your eyes? With wearable augmented reality displays, this wish will become a reality. Data from your computer and the Internet will become instantly accessible and viewable without having to access another device. The reality you see in front of you is improved, or augmented, with additional visual information using projected images.

Bringing up information about a visual image is not new. Several search engines already have the ability to identify an image simply by looking for similar images in their databases. In addition, many types of software can do the same with faces, looking at key points in the image in order to identify that individual. These augmented reality displays will take that technology one step further by integrating it with wearable glasses or contact lenses. Whether you look at a landmark, textbook, or person, the computer connected to that display will be able to retrieve the information you need and place it in your field of vision. So if you forgot the name of the person greeting you in the coffee shop, do not worry. Her name and brief biography will be retrieved from her social networking account and be displayed in front of you in time to properly return the greeting.

Identification of people and objects is not the only use of augmented reality. As technology continues to shrink in size, the device will be able to perform all the tasks of your smartphone. You will be able to look at the sky and see information about today's weather. Text message and incoming call notifications

can appear in front of you. Prices from various online stores will appear by the time you ask your friend where he got that new T-shirt. And of course, integrated GPS will display arrows in front of you and guide you as you walk through unfamiliar city streets.

Although this technology will likely be available in the next few years, there are some challenges. First, you have the issue of powering the device. Something as small as a pair of glasses or contact lenses may not have room for a battery large enough to power it all day. Another issue involves limitations of human

vision. Normally, our eyes find it difficult to focus on objects that are placed very close to them. Researchers have come up with various solutions to fix this problem, but they need to make it comfortable for the eyes to shift focus between the information being projected up close to the real-world object that could be far away. Lastly, there is the issue of comfort. Will these glasses or contact lenses be comfortable to wear all day? Will they make you look strange to those that do not know about augmented reality?

Many companies and universities are working on various types of augmented reality displays. There are a few that have received funding from

the military in order to assist soldiers and pilots. The ones that seem closest to release for the general public are from Google. Prototype eyeglasses from its "Project Glass" division are already being tested by various Google employees. To learn more about this project, visit our website at www.computing2014.com and enter the keyword [projectglass](http://projectglass.com).

Now that you have learned more about augmented reality, do you see yourself wearing these sorts of eyeglasses when they become affordable? Do you think that they can end up being a dangerous distraction?



VISUAL SUMMARY

Input and Output

KEYBOARDS



Input is any data or instructions that are used by a computer. **Input devices** are hardware used to translate words, sounds, images, and actions that people understand into a form that the system unit can process. These include keyboards, pointing, scanning, image capturing, and audio-input devices.

Keyboards convert numbers, letters, and special characters that people understand into electrical signals. These signals are sent to, and processed by, the system unit.

Keyboards

There are four basic categories of keyboards: traditional, notebook, virtual, and thumb.

- **Traditional keyboards**, used on desktop and larger computers. Standard keyboard has 101 keys. **Toggle keys** turn features on and off. **Combination keys** perform actions when combinations of keys are held down.
- **Notebook keyboards**, used on notebook computers. Smaller than traditional keyboard with fewer keys. Typically does not have numeric keypad or standard location for function and navigation keys.
- **Virtual keyboard**, used on tablets and smartphones. Does not have a physical keyboard. Keys displayed on screen and selected by pressing a key's image.
- **Thumb keyboard**, used on smartphones and small portable devices. Very small devices primarily used for texting and connecting to the web.

POINTING DEVICES



Pointing devices provide an intuitive interface with the system unit by accepting pointing gestures and converting them into machine-readable input.

Mice

A **mouse** controls a pointer that is displayed on the monitor. The **mouse pointer** usually appears in the shape of an arrow. Some mice have a **wheel button** that rotates to scroll through information on the monitor. **Optical mouse** is the most widely used. A **cordless** or **wireless mouse** uses radio waves or infrared light waves. Three devices similar to a mouse are **trackballs**, **touch pads**, and **pointing sticks**.

Touch Screens

Touch screens allow users to select actions by touching the screen with a finger or penlike device. **Multitouch** screens accept multiple-finger commands.

Game Controllers

Game controllers provide input to computer games. Widely used controllers include **joysticks**, **dance pads**, **gamepads**, and **motion-sensing devices**.

Stylus

A **stylus** is a penlike device commonly used with tablets and PDAs. Often, a stylus interacts with the computer through **handwriting recognition software** that translates handwritten notes into a form that the system unit can process.

To be a competent end user, you need to be aware of the most commonly used input and output devices. These devices are translators for information into and out of the system unit. Input devices translate words, sounds, and actions into symbols the system unit can process. Output devices translate symbols from the system unit into words, images, and sounds that people can understand.

SCANNING DEVICES



Scanning devices move across text and images to convert them into a form that the system unit can process.

Optical Scanners

An optical scanner (scanner) converts documents into machine-readable form. The three basic types are flatbed, document, and portable.

Card Readers

Card readers interpret encoded information located on a variety of cards. The most common is the magnetic card reader that reads information from a thin magnetic strip on the back of a card.

Bar Code Readers

Bar code readers or scanners (either handheld wand readers or platform scanners) read bar codes on products. The bar code system Universal Product Code (UPC) is widely used in supermarkets.

RFID Readers

RFID readers read RFID (radio-frequency identification) tags. These tags are widely used for tracking lost pets, production, and inventory and for recording prices and product descriptions.

Character and Mark Recognition Devices

Character and mark recognition devices are scanners that are able to recognize special characters and marks. Three types are magnetic-ink character recognition (MICR), optical-character recognition (OCR), and optical-mark recognition (OMR).

IMAGE CAPTURING DEVICES



Image capturing devices create or capture original images. These devices include digital cameras and webcams.

Digital Cameras

Digital cameras are similar to traditional cameras except that images are recorded digitally on a disk or in the camera's memory. Most digital cameras record video too.

Webcams

Webcams are specialized digital video cameras that capture images and send them to a computer for broadcast over the Internet. Webcams are built into many smartphones and tablets, while others are attached to the computer monitor.

AUDIO-INPUT DEVICES

Audio-input devices convert sounds into a form that can be processed by the system unit. By far the most widely used audio-input device is the microphone.

Voice Recognition Systems

Voice recognition systems use a microphone, a sound card, and special software. These systems allow users to operate computers and other devices as well as create documents by using voice commands. Specialized portable voice recorders are widely used by doctors, lawyers, and others to record dictation. Some systems are able to translate dictation from one language to another, such as from English to Japanese.

MONITORS



Output is processed data or information. **Output devices** are any hardware used to provide or to create output.

Monitors (display screens) are the most used output device. Output is often referred to as **soft copy**. Monitors vary in size, shape, and cost. Almost all, however, have some basic distinguishing features.

Features

The most important characteristic of a monitor is its **clarity**, which relates to the quality and sharpness of images. It is a function of several monitor features, including **resolution** (matrix of pixels or picture elements), **dot pitch**, **contrast ratio**, **size**, and **aspect ratio**.

Flat Panel

Flat-panel monitors are the most widely used monitor; most are **LCD (liquid crystal display)**. Most common type is **TFT-LC (thin-film transistor liquid crystal)**. **AMOLED (active-matrix organic light-emitting diode)** is a newer flat-panel technology.

E-book Readers

E-books (electronic books) are traditional printed books in electronic format. **E-book readers (e-readers)** are mobile devices to store and display e-books and other electronic media. They use **e-ink technology**. Tablets can display e-books and have a larger display area but are heavier, more expensive, and more difficult to read in bright light.

Other Monitors

Other types of monitors include **digital (interactive) whiteboards** to project output; **high-definition television (HDTV)** to display clear detailed images; and older monitors using **cathode-ray tubes (CRTs)**.

PRINTERS



Printers translate information processed by the system unit and present the information on paper. Printer output is often called **hard copy**.

Features

Most printers have the same basic features, including **resolution** measured in **dpi (dots per inch)**, **color capability** (most common black ink selection is **grayscale**), **speed** (measured in the number of pages printed per minute), **memory**, and **duplex** (both sides of paper) **printing**.

Inkjet

Inkjet printers spray ink at high speed onto the surface of paper. Most widely used type of printer, reliable, quiet, and inexpensive. The most costly aspect of inkjet printers is replacing the ink cartridges.

Laser

Laser printers use technology similar to photocopying machine involving laser light beam to produce high-quality images. There are two categories: **personal** (less expensive, used by single user) and **shared** (supports color, more expensive, and supports group of users).

Other Printers

There are several other types of printers. These printers include cloud printers, thermal printers, and plotters.

- **Cloud printers** provide printing services to others on the Internet. **Google Cloud Print** is a service that supports cloud printing.
- **Thermal printers** use heat elements to produce images on heat-sensitive paper.
- **Plotters** are special-purpose printers for producing a wide range of specialized output including output from graphics tablets and other graphical input devices.

AUDIO AND VIDEO DEVICES



Audio-output devices translate audio information from the computer into sounds that people can understand. The most widely used are speakers and headsets.

Portable Media Players

Portable media players (digital media players) are electronic devices for storing and playing digital media. Mobile digital television (mobile DTV) technology allows direct broadcast to digital media players as well as smartphones and other computers.

COMBINATION INPUT AND OUTPUT DEVICES

Many devices combine input and output capabilities.

Multifunctional Devices

Multifunctional devices (MFD) typically combine the capabilities of a scanner, printer, fax, and copy machine.

Internet Telephones

Internet telephones send and receive voice communication over the computer networks using voice over IP (VoIP, telephony, Internet telephony, IP telephony). Skype is a widely used VoIP service.

Robots

Artificial intelligence (AI) attempts to mimic human senses, thought processes, and actions. Robotics, an area of AI, uses robots (computer-controlled machines that mimic the motor activities of living things). Four types of robots: perception system, industrial, mobile, and household.

Virtual Reality Headgear and Gloves

Virtual reality (VR) creates 3-D simulated immersive experiences. Virtual reality hardware includes headgear and gloves. Applications include training environments, such as in aviation, surgery, spaceship repair, or nuclear disaster cleanup.

ERGONOMICS



Ergonomics is the study of human factors related to things people use. Concerned with fitting the task to the user rather than forcing the user to contort to do the task, it involves devising ways that input and output devices can be used and designed to increase ease of use and decrease health risks.

Recommendations

Some recommendations to avoid physical discomfort are

- **Eyestrain and headache.** To make the computer easier on the eyes, take a 15-minute break every hour or two; keep everything you're focusing on at about the same distance; and clean the screen periodically.
- **Back and neck pain.** To help avoid back and neck problems, use adjustable equipment; chairs should adjust for height, angle, and back support; monitors should be at eye level or slightly below. Use a footrest, if necessary, to reduce leg fatigue.
- **Repetitive strain injury.** Repetitive strain injury (RSI) is caused by fast, repetitive work and can generate neck, wrist, hand, and arm pain. One particular type of RSI, carpal tunnel syndrome, found among heavy computer users, consists of damage to nerves and tendons in the hands. Ergonomically correct keyboards help prevent injury. Take frequent, short rest breaks and gently massage hands.

CAREERS IN IT

Technical writers prepare instruction manuals, technical reports, and other documents. An associate or a college degree in communication, journalism, or English and a specialization in, or familiarity with, a technical field are required. Salary range is \$41,000 to \$78,000.

KEY TERMS

- active display area (163)
- active-matrix organic light-emitting diode (AMOLED) (163)
- artificial intelligence (AI) (169)
- aspect ratio (163)
- bar code (159)
- bar code reader (159)
- bar code scanner (159)
- card reader (159)
- carpal tunnel syndrome (173)
- cathode-ray tube (CRT) (165)
- clarity (162)
- cloud printer (167)
- combination key (155)
- contrast ratio (163)
- cordless mouse (156)
- dance pad (157)
- digital camera (160)
- digital media player (168)
- digital video camera (160)
- digital whiteboard (165)
- display screen (162)
- document scanner (159)
- dot pitch (163)
- dots per inch (dpi) (166)
- duplex printing (166)
- e-book reader (163)
- e-books (163)
- e-ink (163)
- e-reader (163)
- electronic books (163)
- ergonomics (172)
- flat-panel monitor (163)
- flatbed scanner (159)
- game controller (157)
- gamepads (157)
- gloves (172)
- Google Cloud Print (167)
- grayscale (166)
- handwriting recognition software (157)
- hard copy (165)
- headgear (172)
- headsets (168)
- high-definition television (HDTV) (165)
- household robot (169)
- immersive experience (172)
- industrial robot (169)
- inkjet printer (166)
- input (154)
- input device (154)
- interactive whiteboard (165)
- Internet telephone (169)
- Internet telephony (169)
- IP telephony (169)
- joystick (157)
- keyboard (154)
- laser printer (167)
- liquid crystal display (LCD) (163)
- magnetic card reader (159)
- magnetic-ink character recognition (MICR) (160)
- mobile digital television (168)
- mobile DTV (168)
- mobile robot (169)
- monitor (162)
- motion-sensing device (157)
- mouse (156)
- mouse pointer (156)
- multifunctional device (MFD) (169)
- multitouch screen (157)
- notebook keyboard (155)
- optical-character recognition (OCR) (160)
- optical-mark recognition (OMR) (160)
- optical mouse (156)
- optical scanner (158)
- output (162)
- output device (162)
- perception system robot (169)
- personal laser printer (167)
- photo printer (161)
- picture element (162)
- pixel (162)
- pixel pitch (163)
- platform scanner (159)
- plotter (167)
- pointing device (156)
- pointing stick (157)
- portable media player (168)
- portable scanner (159)
- printer (165)
- repetitive strain injury (RSI) (173)
- resolution (162, 166)
- RFID reader (160)
- RFID (radio-frequency identification) tag (159)
- robot (169)
- robotics (169)
- scanner (158)
- scanning devices (158)
- shared laser printer (167)
- Skype (169)
- soft copy (162)
- speakers (168)
- stylus (157)
- technical writer (174)
- telephony (169)
- thermal printer (167)
- thin-film transistor liquid crystal (TFT-LC) (163)
- thumb keyboard (155)
- toggle key (155)
- touch pad (157)
- touch screen (157)
- trackball (156)
- traditional keyboard (155)
- Universal Product Code (UPC) (159)
- virtual keyboard (155)
- virtual reality (VR) (172)
- voice over IP (VoIP) (169)
- voice recognition system (161)
- wand reader (159)
- webcam (161)
- wheel button (156)
- wireless mouse (156)

To test your knowledge of these key terms with animated flash cards, visit our website at www.computing2014.com and enter the keyword [terms6](#). Or use the free *Computing Essentials 2014* app.

MATCHING

Match each numbered item with the most closely related lettered item. Write your answers in the spaces provided.

- | | |
|------------------------|--|
| a. active display area | ___ 1. Pressing this key turns a feature on or off. |
| b. digital camera | ___ 2. Input device that controls a pointer that is displayed on the monitor. |
| c. dot pitch | ___ 3. A penlike device commonly used with tablet PCs and PDAs. |
| d. MagicJack | ___ 4. Bar code readers use either handheld wand readers or platform ____. |
| e. mouse | ___ 5. Bar code system used by many electronic cash registers. |
| f. plotters | ___ 6. Records images digitally on a disk or in its memory. |
| g. scanners | ___ 7. The distance between each pixel. |
| h. stylus | ___ 8. A monitor feature that is measured by the diagonal length of the viewing area. |
| i. toggle key | ___ 9. Special-purpose printers for creating maps, images, and architectural and engineering drawings. |
| j. UPC | ___ 10. A provider of lower-cost options for VoIP. |

For an interactive matching practice test, visit our website at www.computing2014.com and enter the keyword [matching6](#). Or use the free *Computing Essentials 2014* app.

OPEN-ENDED

On a separate sheet of paper, respond to each question or statement.

1. Define input and input devices.
2. Describe the different types of keyboard, pointing, scanning, image capturing, and audio-input devices.
3. Define output and output devices.
4. Describe the features and different types of monitors and printers.
5. Describe audio and video devices including portable media devices and mobile DTV.
6. Discuss combination input and output devices, including multifunctional devices, Internet telephones, robots, and virtual reality headgear and gloves.
7. Define ergonomics, and describe ways to minimize physical discomfort.

DISCUSSION

Respond to each of the following questions.

1 Making IT Work for You: E-BOOKS

Are you tired of carrying a book bag filled with textbooks? Review the Making IT Work for You: E-books on page 164 and then respond to the following: (a) Have you ever purchased or read an e-book? If so, what was your most recent one? If not, have you considered it? Why or why not? (b) Download and install an e-book app (desktop, tablet, or smartphone version), and then download a free e-book for that particular service. Identify the e-book you selected, and describe your experience with that e-book service, as well as some of the in-book features of its app. (c) Based on your experience, will you be purchasing more e-books in the future? Why or why not? (d) Would you consider buying future textbooks as e-books? Discuss the advantages and disadvantages of e-book textbooks.



2 Making IT Work for You: SKYPE

Do you already use a communication tool that lets you keep in touch with your friends and family? Review the Making IT Work for You: Skype on pages 170 and 171 and then respond to the following: (a) Have you ever used Skype or a similar service? If so, what service have you used, and what do you typically use it for? If you have not used Skype or a similar service, do you expect to in the future? Why or why not? (b) If you do not have a Skype account, create a free one, and add one of your classmates as a contact. Try a few of Skype's features after connecting with your classmate, and then describe your experience with those features. (c) Discuss the advantages and disadvantages of using Skype or a similar service for communication. (d) Do you currently use VoIP with your Internet provider or any other online service? Why or why not?



3 Explorations: LED TECHNOLOGY

Did you know that AMOLED is just one of several types of LED monitors and TVs? Review the Explorations box on page 163 and then respond to the following: (a) What is the primary difference between LCD and LED? Why does the article claim that many LED TVs are not actually LED TVs? (b) What is the technical difference between LED and OLED? What benefits does OLED offer? (c) What is AMOLED? Where do you typically find this technology? (d) Do you see yourself buying an LED monitor or TV? Why or why not?

4 Explorations: ROBOTS

Did you know that humanlike robots are being developed for research and education? Review the Explorations box on page 169 and then respond to the following: (a) How does this robot move? How is it able to maintain humanlike balance and stability? (b) How does this robot “see”? How does it “hear”? Can it recognize human voices and faces? If so, how? (c) How does this robot sense nearby objects? Can it sense if it is being touched? If so, how? (d) Do think this robot can be beneficial in education? Why or why not?

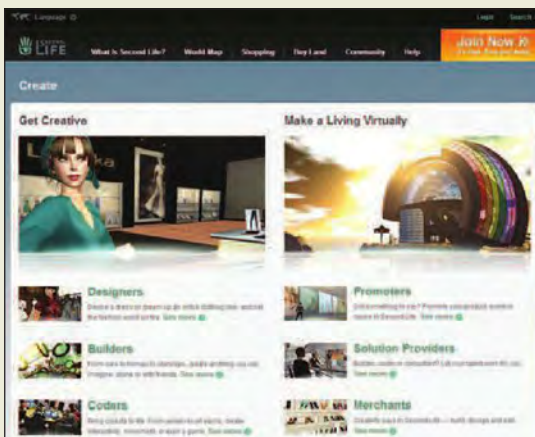


5 Ethics: WEBCAMS

Webcams can be set up almost anywhere by anyone. Once in place, these webcams can continuously broadcast images to the Internet. Some images can be very embarrassing to the individuals who were recorded. Review the Ethics box on page 161 and respond to the following: (a) Would you feel uncomfortable if a hidden webcam was recording you when you entered a private home or business? What if the video was broadcast online? Why or why not? (b) Do you think recording and broadcasting images without permission is an ethical or a privacy concern? What if that person is in a public place at the moment the recording took place? In your response, consider whether such ethical concerns are significant enough to warrant new laws and regulations. (c) Many cities use webcams or video cameras for traffic control purposes. If those cameras record a person engaged in an illegal or questionable activity that is not related to traffic, should law enforcement be able to use the video in court? Should a concerned parent or jealous spouse be able to access that video? Defend your responses.

6 Ethics: VIRTUAL REALITY

Virtual reality environments can allow individuals to engage in violent or sexual aggression toward another actor in order to reach a goal. Even though the situation is simulated, there are ethical concerns about the actions a person chooses in such environments. Review the Ethics box on page 172 and then respond to the following: (a) Are there any dangers of using the virtual world to escape the rules of the real world? Can such a person become dangerous when coming out of the virtual environment? Defend your answers. (b) Do you think accepted ethical standards in the real world should also govern behavior in virtual environments? Should they apply to those who write the software? How about the users? Why or why not? (c) Instead of sending criminals to prison, what if they were required to spend extended time in a virtual environment that functioned as a reprogramming tool to change their attitude and behavior? Would this be ethical? Why or why not?



7 Environment: INKJET PRINTERS

Have you considered the environmental impact of using your inkjet printer? Review the Environment box on page 166 and then respond to the following: (a) How often do you use your printer at home? What sort of items do you typically print? (b) Have you considered any alternatives to printing? If so, what are those alternatives? Why would or wouldn't you use these alternatives? (c) Does the manufacturer of your ink cartridges use recycled plastic? Support your answer with details from the manufacturer's website. (d) Find a store near you that accepts used ink cartridges. Name the store, and provide details on the benefits it gives you for turning in cartridges.

8 Environment: ROBOTS AND POLLUTION

Did you know that robots are already being used to help the environment? Review the Environment box on page 169 and then respond to the following: (a) List two ways in which robots are helping the environment. (b) Using a search engine, find additional information on the robotic fish that will help detect pollution. Briefly describe how the robot will perform its function. Do you believe that this robot will eventually enjoy widespread use? Why or why not? (c) Do you see robots providing additional help with the environment in the future? Do you feel that future robots could harm the environment in any way? Explain your responses.