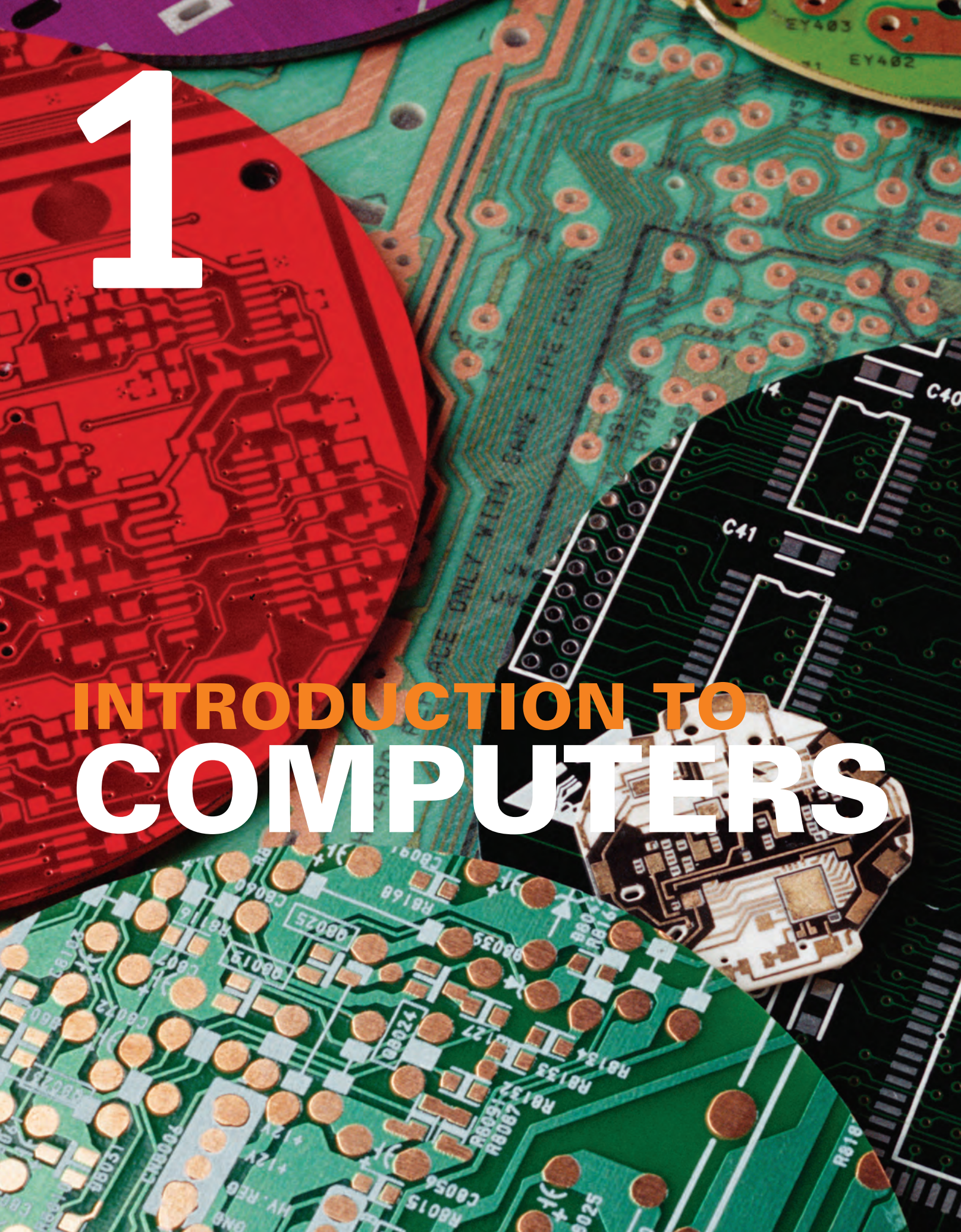

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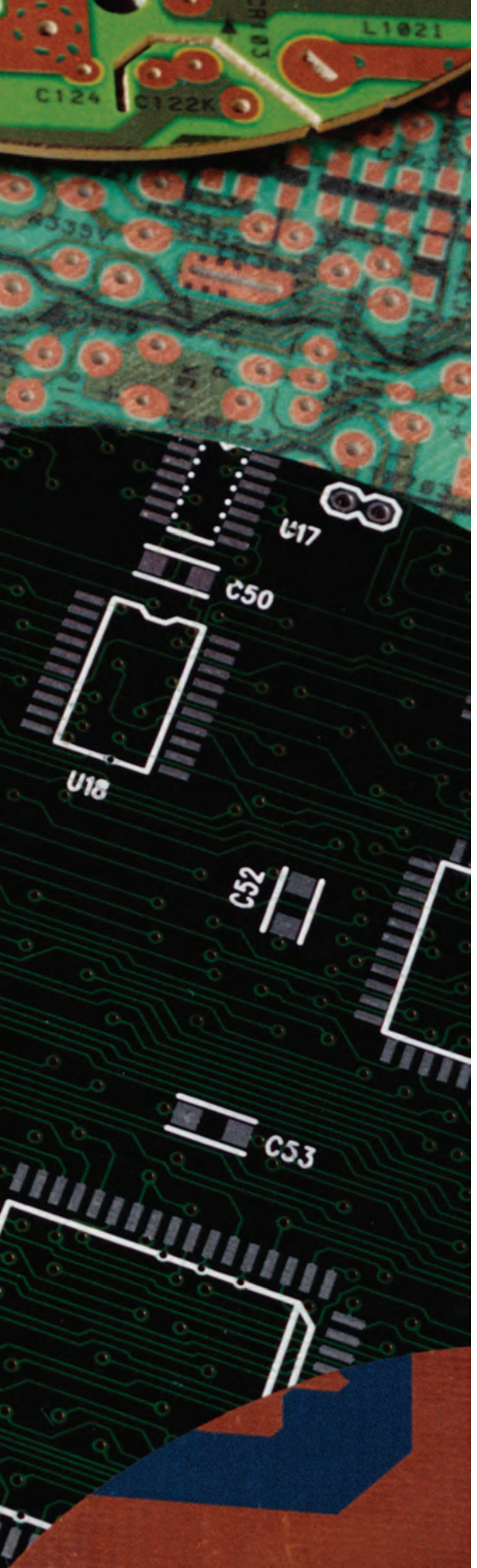
INTRODUCTION TO COMPUTERS



LEARNING OBJECTIVES

1.1 Define computer, and distinguish between analog and digital computer designs, p. 4

1.2 Identify the main types of single user and multi-user computers, p. 5

1.3 Discuss how computers have shaped our current world, p. 10

1.4 List the parts of a complete computer system and discuss the phases of the information processing cycle, p. 20

1.5 Identify four basic categories of computer hardware, p. 22

1.6 Discuss the role of software as a part of the computer, p. 27

1.7 Explain the crucial link between data, users and technology, p. 28

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- LO1.2 Types of Digital Computers, p. 5
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LESSON 1B: Looking Inside the Computer

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- LO1.6 Software Brings the Machine to Life, p. 27
- LO1.7 Data and Users, p. 28

Chapter Overview

This chapter introduces you to the computer, inside and out. You'll learn about the types of computers that are in use today, and you'll get an overview of different ways that computers are used in our society. You will take a look inside a computer and see some of the parts used to construct it, and you'll learn how the machine, the software programs, and users all work together to transform a computer from a calculating engine to a data-processing marvel. Where have you already used a computer? How would you like to use computers in the future?

LESSON 1A:

Computers and Their Uses

Computers are everywhere!

From office desks to kitchen tables, from library tables to people's laps in coffee shops, the screen and keyboard combination is a familiar sight. But if you look more carefully, you'll discover that computers exist in even more places than you first realize. Cash registers in stores have computers inside that calculate prices and help manage inventory. Most cars produced today have diagnostic computers to help find problems and improve performance. Cell phones contain computers, and wristwatches often rely on simple computers for stopwatch and calendar functions.

Since the 1970s, computers have rapidly reshaped personal and business life as we know it. Factories and industrial companies often use computer-controlled machinery. Professional occupations such as law, engineering, medicine, and finance use computers almost universally. Many workers who once had little use for technology now interact with computers almost every minute of the workday.

At home, people use computers to read the news, play games, and keep in touch with family and friends. News from around the world is instantly available. More and more people have international friends and colleagues, and they can use computers to communicate.

1.1 What Is a Computer?

In the simplest terms, a **computer** is a machine that accepts some kind of input, performs actions and calculations according to a set of instructions, and returns the result of its calculations. All computers, regardless of their size, purpose, or type, follow this definition.

The computer in a stopwatch, for example, accepts a command to start (a person pressing the button), counts the passing of time, and shows the time on a screen to the person holding the stopwatch. A personal computer accepts input from a person via the keyboard, runs programs like word processors or games, and displays the results on the screen. A diagnostic computer in a car accepts input from engine parts, sorts the data, and stores performance information for a mechanic to retrieve when a problem occurs.

Computer design is separated into two categories: analog and digital. You don't hear much about analog computers anymore, and that's because they've been largely replaced by digital computers.

Analog computers, which have been around in one form or another since ancient times, are usually mechanical. For input, they rely on some kind of fixed starting point, like fluids at certain levels or wires connecting electrical components together. As they operate, their physical state changes—fluid levels rise and fall, for example—to indicate solutions or new input. Analog computers can be very complex and may employ thousands of parts to construct, but in spite of all that complexity, each analog computer will solve only one specific kind of problem. An analog computer designed to calculate a differential equation cannot also be used to calculate where a bomb will land when dropped from an airplane.

The computers discussed in this book and found throughout the world are known as digital computers, because they work by processing sequences of numbers. Digital computers convert their input and operating instructions into numeric codes and perform calculations with those codes. The calculations are performed in strict, single steps; however, because they use numbers, digital computers can execute their instructions extremely fast. Unlike their analog counterparts, digital computers rely on electrical components rather than heavy gears. Digital computers are also flexible. The same digital computer can run programs to calculate differential equations, determine where a dropped bomb will fall, store recipes for tonight's dinner, and show you a map with the best route to the airport.

Figure 1.1 Computers have become so commonplace that sometimes we hardly notice people carrying them.

Fact Check

1. The two basic types of computer design are
   a. PC and Mac
   b. analog and digital
   c. wired and wireless
2. Digital computers are so named because
   a. they are made by a company called Digital Manufacturing
   b. they process all their data and instructions as numbers
   c. they don't require levers or hydraulics

1.2 Types of Digital Computers

While some computers are designed to work with many people at the same time, most computers are meant to be used by only one person at a time. Those computers are known as **personal computers (PCs)**. It's common for personal computers to have separate work spaces and storage for several different users (those in a computer lab are probably set up that way), but only one user can work with the machine at a time.

Personal computers are also called **microcomputers** because they are among the smallest computers created for people to use. Although personal computers are used by individuals, they can be connected together to create networks, allowing users to share information from computer to computer. In fact, networking—the process of connecting to and sharing data between devices and locations—has become one of the most important jobs of personal computers, and even tiny handheld computers can now be connected to networks. You will learn about computer networks in Chapter 2.

Some computers, while still following the same fundamental design of all digital computers, are specially created to handle the needs of many users at the same time. These powerful systems are most often used by businesses or schools, and are commonly found at the heart of an organization's network. Each user interacts with the computer through his or her own input and output hardware, freeing people from having to wait their turn at a single keyboard and monitor. The largest organizational computers support thousands of individual users at the same time, from thousands of miles away. While some of these large-scale systems are devoted to a special purpose, enabling users to perform only a few specific tasks, many organizational computers are general-purpose systems that support a wide variety of tasks.

Figure 1.2 The same technology that helps us build bridges and airplanes is also a great fit for family game night.

Six primary types of computers are designed to be used by one person at a time:

- Desktop computers
- Workstations
- Notebook (or laptop) computers
- Tablet computers
- Handheld computers
- Smart phones

There are four main types of multi-user computers:

- Network servers
- Mainframe computers
- Minicomputers
- Supercomputers

DESKTOP COMPUTERS

Figure 1.3 The screen, keyboard, and system unit of a desktop computer is a familiar sight practically everywhere.

The most common type of personal computer is the **desktop computer**—a PC that is designed to sit on (or more typically under) a desk or table.

Today's desktop computers are powerful and versatile, and they are used for an amazing array of tasks. Not only do these machines enable people to do their jobs with greater ease and efficiency, but they can be used to communicate, produce music, edit photographs and videos, play sophisticated games, and much more. Used by everyone from preschoolers to nuclear physicists, desktop computers are indispensable for learning, work, and play.

As its name implies, a desktop computer is a full-size computer that is too big to be easily carried around. The main component of a desktop PC is the **system unit**, which is the case that houses the computer's critical parts, such as its processing and storage devices.

WORKSTATIONS

A **workstation** is a specialized, single-user computer that typically has more power and features than a standard desktop PC. These machines are popular among scientists, engineers, and animators who need a system with greater-than-average speed and the power to perform sophisticated tasks. Workstations often have large, high-resolution monitors and accelerated graphics-handling capabilities, making them suitable for advanced architectural or engineering design, modeling, animation, and video editing.

NOTEBOOK COMPUTERS

Notebook computers, as their name implies, approximate the shape of a writing notebook and easily fit inside a briefcase. Because people frequently set these devices on their lap, they are also called **laptops**. Notebooks have a "clam-shell" design; during use, the notebook's lid is raised to reveal a thin monitor and a keyboard. When not in use, the device folds up for easy storage.

Notebooks are fully functional microcomputers; the people who use them need the power of a full-size desktop computer wherever they go. Along with the monitor and keyboard, notebooks also typically contain a mouse, DVD player, and wireless networking capability.

Notebook computers come in a variety of sizes, with different sets of features and hardware to accommodate a wide range of user preferences. Notebook computers can operate on either an AC adapter or special batteries. They generally weigh less than eight pounds, and some even weigh less than three pounds.

Some notebook systems are designed to be plugged into a **docking station**, which allows the notebook to hook up to devices and services like full-sized keyboards, large monitors, and local networks.

Recent arrivals to the notebook scene are small and inexpensive computers referred to as **netbooks**. Netbooks are small, compact computers with reduced processing power and often without extra devices such as DVD drives. They are designed both for notebook shoppers with a very low budget and for users who only need a computer for casual use.

Figure 1.4 Notebook computers help people get their work done no matter where they are.

Figure 1.5 A tablet PC.

Because of their portability, notebook PCs fall into a category of devices called **mobile computers**—systems small enough to be carried by their user.

TABLET PCS

The **tablet PC** is the newest development in portable, full-featured computers. Tablet PCs offer all the functionality of a notebook PC, but they are lighter and can accept input directly from a special pen—called a **stylus** or a **digital pen**—or even the user's fingers. Some of the newer models can display an image of a keyboard on the screen and allow the user to type.

Many tablet PCs also have a built-in microphone and special software that accepts input from the user's voice. A few models even have a fold-out keyboard, so they can be transformed into a standard notebook PC. Tablet PCs run specialized versions of standard programs and can be connected to a network.

The popularity of tablet PCs has exploded in recent years both for business and personal use. The combination of portable size and friendly interface makes them ideal in a wide range of circumstances for note-taking, document sharing, and online communication.

HANDHELD PCS

Handheld personal computers (or just **handheld PCs**) are computing devices small enough to fit in your hand. Though they can be indispensable tools for many types of users, their small size and limited processing power puts them in a different category from notebook and tablet computers. Handheld PCs are typically used for applications that help connect mobile users to online resources; provide portable entertainment in the form of games, music and video; and assist with mobile computing tasks such as taking notes and managing address books or task lists. Many users rely heavily on their handheld PC to stay current all day long with the latest news from the world and their friends.

As handheld PCs became widely popular in the 1990s and early 2000s, they were commonly known as **personal digital assistants (PDAs)**. Early PDAs had a limited set of software programs that they could run, many of which were targeted toward note-taking, small spreadsheets, and appointment management. Input to the PDA was commonly accomplished via tapping and drawing on a touch-sensitive screen with a stylus. Now, handheld PCs often have intuitive and shortcut-rich user interfaces with colorful displays, and touch screens that can accept various kinds of fingertip taps and swipes for input.

The term **smart phone** was coined as manufacturers of cellular telephones began including PDA features and programs in their telephones. The combination of PDA and cell phone produced a convenient multi-function device that proved

Figure 1.6 Smart phones provide communication, computing power, and more.

highly popular not only with business and technical PDA users, but also with cell phone consumers. Not every handheld PC user prefers to combine their phone and handheld computer together, so sales of devices both with and without phones are increasing. The concept of the PDA is alive and well, even though the "PDA" term itself is rapidly becoming a thing of the past.

Manufacturers of handheld PCs have made rapid advances in their products as a result of this widespread acceptance and demand for mobile computing devices. While the PDA of the past provided a limited set of business-oriented software programs for their users, vast libraries of programs are now available for download that support business and entertainment interests alike.

NETWORK SERVERS

Today, most organizations' networks are based on personal computers. Individual users have their own desktop computers, and those computers are linked together in a network to allow convenient file and information sharing between users. In cases where all the people use their computers for a common purpose (for example, running e-mail programs or working on documents), a special, central computer called a **network server** is added to the network.

A network server is a powerful personal computer with special software and equipment that enable it to function as the primary computer in the network. Though their exact functions are different from organization to organization, network servers all have the basic task of making documents, programs, and in some cases other computer hardware available to others.

For example, a network server might run the e-mail services for a company. Rather than having each employee run his or her own mail program, employees simply access the central e-mail program running on the server to retrieve their messages.

Network servers are also responsible for sending Web pages to users who are browsing the Internet; a single server can send its Web pages to thousands of people visiting the site that it hosts.

Often, the requests from the network grow so large and complex that a single PC cannot handle the job by itself. In such cases, network server computers are linked together to share the load. In some cases, dozens or even hundreds of individual servers work together to manage data processing requests. When set up in such groups—sometimes called *clusters* or *server farms*—network servers may not even resemble standard PCs. The big case that holds the typical PC system unit is reduced to a thin unit called a "blade," which can slide in and out of a rack that holds many of its companion servers. In these large networks, PC groups are often serving different purposes, such as supporting a certain set of users, handling printing tasks, enabling Internet communications, and so on.

Figure 1.7 Blades are full PCs in a narrow box suitable for side-by-side installation.

Depending on how the network is set up, users may be able to access the server in multiple ways. In an office, users might have a standard desktop PC on their desk that is permanently connected to the network. Mobile users may be able to connect a notebook PC or a handheld device to the network wirelessly.

MAINFRAME COMPUTERS

Mainframe computers are large, powerful systems used in organizations such as insurance companies and banks, where many people frequently need to use the same data.

In a traditional mainframe environment, each user accesses the mainframe's resources through a device called a **terminal**. There are two kinds of terminals. A dumb terminal does not process or store data; it is simply an **input/output (I/O) device** that functions as a window into a computer located somewhere else. An intelligent terminal can perform some processing operations, but it usually does not have any storage. In some mainframe environments, however, workers can use a standard personal computer to access the mainframe.

The largest mainframes can handle the processing needs of thousands of users at any given moment. But what these systems offer in power, they lack in flexibility. Most mainframe systems are designed to handle only a specific set of tasks. In your state's Department of Motor Vehicles, for example, a mainframe system is probably devoted to storing information about drivers, vehicles, and driver's licenses, but little or nothing else. By limiting the number of tasks the system must perform, administrators preserve as much power as possible for required operations.

Figure 1.8 Mainframe computers are often housed alone in special rooms, away from their users.

Fact Check

1. What is the most common type of single-user computer?
   a. Desktop computer
   b. Minicomputer
   c. Analog computer
2. List the four types of multi-user computers.

MINICOMPUTERS

First released in the 1960s, **minicomputers** got their name because of their small size relative to other computers of the day. The capabilities of a minicomputer are somewhere between those of mainframes and personal computers. For this reason, minicomputers are often called **midrange computers**. Like mainframes, minicomputers can handle much more input and output than personal computers. Although some "minis" are designed for a single user, the most powerful minicomputers can serve the input and output needs of hundreds of users at a time. Users can access a central minicomputer through a terminal or a standard PC.

SUPERCOMPUTERS

Supercomputers are the most powerful computers and physically they are some of the largest. These systems can process huge amounts of data, and the fastest supercomputers can perform nearly two quadrillion calculations per second.

Figure 1.9 Supercomputers like Cray's XT5 Jaguar are massive machines, integrating hundreds of thousands of smaller processors together.

Some supercomputers link together hundreds of thousands of processors. Supercomputers are ideal for handling large and highly complex problems that require extreme calculating power. For example, supercomputers are actively used in the mapping of the human genome, forecasting weather, and modeling complex processes like nuclear fission.

1.3 Computers in Society

How important are computers to our society? People often talk in sweeping terms about computers and their impact on our lives, with expressions like "computers have changed our world" or "computers have changed the way we do everything." Such statements may strike you at first as exaggerations, but if you stop and really think about the effect computers have had on our daily lives, they may not be so far off the mark.

To better gauge the impact of computers, think of the impact of other inventions. Can you imagine, for instance, the many ways in which American life changed after the introduction of the automobile? Consider a few examples:

- Because of the car, people were able to travel farther than ever before, and this created huge opportunities for businesses to meet the needs of the traveling public.
- Because vehicles could be mass-produced, the nature of manufacturing and industry changed, and throngs of people began working on assembly lines.
- Because of road development, suburbs became a feasible way for people to live close to a city without actually living in one.
- Because of car travel, motels, restaurants, and shopping centers sprang up in places where there had previously been nothing.

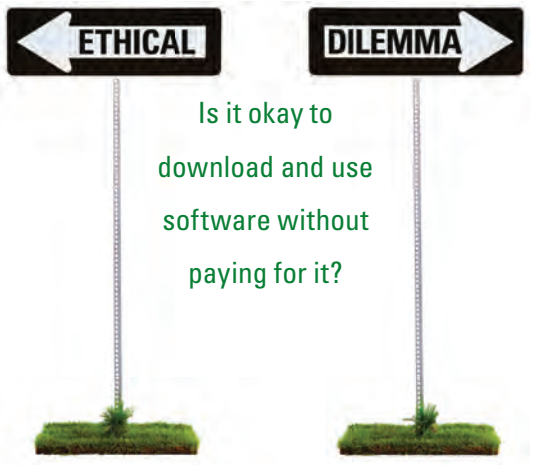
Think of other great inventions and discoveries, such as electricity, the telephone, or the airplane. Each, in its own way, brought significant changes to the world and to the ways people lived and spent their time. Today, still relatively soon after its creation, the digital computer is beginning to make its mark on society.

WHY ARE COMPUTERS SO IMPORTANT?

People can list countless reasons for the importance of computers. For someone with a disability, for example, a computer may offer freedom to communicate, learn, or work without leaving home. For a sales professional, a PC may mean the ability to communicate whenever necessary, track leads, and to manage an ever-changing schedule. For a researcher, a computer may be the workhorse that does painstaking and time-consuming calculations.

But if you took all the benefits that people derive from computers, mixed them together, and distilled them down into a single element, what would you have? The answer is simple: information.

Computers are important because information is so essential to our lives, and information is much more than the stuff you see and hear on television. Facts in a textbook or an encyclopedia are information, but only



Yesterday, you and your friend Tracy were looking at family photos on her computer. Tracy showed you a hilarious picture of her little nephew that had been altered to make it look like he was dancing with penguins. You asked her where she'd found the thousand dollars to buy fancy photo-editing software.

"I found this great site on the Web where you can download old versions of software for free," she replied. "The photo software company doesn't support this version anymore, but it works perfectly."

Looking through the site Tracy mentioned, you see that you could easily get the photo software and lots of other programs. The download site is safe, virus-free, doesn't track who accesses the site or downloads programs, and contains only software versions that are out of date and no longer supported.

QUESTIONS

1. Would it be ethical to download and use the program even though you're not paying for it?
2. Is this situation different from finding a copy of this same software at a garage sale and paying the person in the driveway a few dollars to take it home? If so, how?

one kind. Mathematical formulas and their results are information, too, as are the plans for a building, or the recipe for a cake. Pictures, songs, addresses, games, poems, menus, shopping lists, résumés—the list goes on and on. All these things and many others can be thought of as information, and they can all be stored and processed digitally by computers. In fact, that ready access to information has created some ethical gray areas along with learning opportunities. For an example of one such gray area, see the "Ethical Dilemma" feature.

When you consider the importance of computers in our society, think about the importance of information. As tools for working with information, and for creating new information, computers may be one of humanity's most important creations.

Let's take a look at where computers are found in our society and what they do there.

Home In many American homes, the family computer is nearly as important as the refrigerator or the washing machine. In fact, a growing number of families have multiple PCs in their homes; in most cases, at least one of those computers has an Internet connection. Why do home users need their computers?

- **Communication.** Electronic mail (e-mail) allows family members to communicate with one another and to stay in contact with friends and coworkers. Social networking programs such as Facebook help extended families and groups of friends stay in touch and share their lives. Services like Twitter take the "keep in touch" idea even further, allowing people to broadcast quick updates, thoughts, and items of interest throughout the day. It's more common than ever for computer users to meet and make friends with people all over the world, no matter where they live.
- **Business work done at home.** Thanks to computers and Internet connections, more people are working from home than ever before. It is possible for many users to connect to their employer's network from home. Computers also are making it easier for people to start their own home-based businesses.
- **Schoolwork.** Today's students are increasingly reliant on computers, and not just as a replacement for typewriters. The Internet is replacing printed books as a reference tool, and easy-to-use software makes it possible for even young users to create polished documents.
- **Entertainment.** Computers and video game consoles are intensely popular, with an endless variety of games from solitaire to simulating your own living room rock band. People can play games alone, with a family member, or go online to play with tens of thousands of others in a single, massive fantasy or sci-fi world. PCs can also serve as

media centers, storing music, videos, and movies for on-demand playback on other computers, consoles, and televisions throughout the home.

- **Creativity.** Poetry, music, painting, essays on the state of the world, funny stories—these once required publishers and marketing efforts to produce. Now, with blogs, personal Web pages, and Web sites for sharing pictures and video clips, people can create anything to their hearts' content and share it with an audience.
- **Finances and Shopping.** Computers and personal finance software can make balancing your checkbook an enjoyable experience. Well, almost. At any rate, they certainly make it easier. Home users rely on their PCs for bill paying, investing, and other financial chores. They also use computers to spend what they earn, shopping online for everything from cars to collectibles.

Computer technology has also brought more opportunities for education to a large population. With Internet access available in small towns and remote areas, students can join online classes taught at universities around the world, learning new subjects and completing classes without having to leave their hometowns.

Small Business Many of today's successful small companies simply could not exist without computer technology. Each year, hundreds of thousands of individuals launch businesses based from their homes or in small-office locations. They rely on inexpensive computers and software not only to perform basic work functions but also to manage and grow their companies.

These tools enable business owners to handle tasks—such as daily accounting chores, inventory management, marketing, payroll, and many others—that once required the hiring of outside specialists. As a result, small businesses become more self-sufficient and reduce their operating expenses.

> "Many of today's successful small companies simply could not exist without computer technology."

Education More and more schools are adding computer technology to their curricula, not only teaching pure computer skills, but also incorporating those skills into other classes. Students may be required to use a drawing program, for example, to draw a plan of the Alamo for a history class, or use spreadsheet software to analyze voter turnouts during the last century's presidential elections. Educators see computer technology as an essential learning requirement for all students, starting as early as preschool. Even now, basic computing skills such as keyboarding are being taught in elementary schools, and kids are taught how to search online for information at an early age.

Businesses both small and large can also benefit from using computers and networks to allow their employees to work from home, or to support satellite offices away from the main corporate site. Workers who would face a prohibitive commute or who want to live in a remote location can still be productive, connected employees via their computers.

Industry Today, enterprises use different kinds of computers in many combinations. A corporate headquarters may have a standard PC-based network, for

Figure 1.10 Users of all ages at home can use computers for work, creative expression and play.

example, but its production facilities may use computer-controlled robotics to manufacture products. Here are just a few ways computers are applied to industry:

- **Design.** Nearly any company that designs and makes products can use a computer-aided design or computer-aided manufacturing system in their creation.
- **Shipping.** Freight companies need computers to manage the thousands of ships, planes, trains, and trucks that are moving goods at any given moment. In addition to tracking vehicle locations and contents, computers can manage maintenance, driver schedules, invoices and billing, and many other activities.
- **Process control.** Modern assembly lines can be massive, complex systems, and a breakdown at one point can cause chaos throughout a company. Sophisticated process-control systems can oversee output, check the speed at which a machine runs, manage conveyance systems, and look at parts inventories, with very little human interaction.

Figure 1.11 Police officers use computers to quickly access vital information on the job.

Government Not only are governments big consumers of technology, but they help to develop it as well. As you will learn in Chapter 4, the U.S. government played a key role in developing the Internet. Today, computers play a crucial part in nearly every government agency:

- **Population.** The U.S. Census Bureau was one of the first organizations to use computer technology, recruiting mechanical computers known as "difference engines" to assist in tallying the American population in the early 20th century.
- **Taxes.** Can you imagine trying to calculate Americans' tax bills without the help of computers? Neither could the Internal Revenue Service. In fact, the IRS now encourages taxpayers to file their tax returns online via the Internet.
- **Military.** Some of the world's most sophisticated computer technology has been developed primarily for use by the military. In fact, some of the earliest digital computers were created for such purposes as calculating the trajectory of missiles. Today, for tasks including everything from payroll management and weapons control to games and simulations that teach combat skills, the armed forces use the widest array of computer hardware and software imaginable.
- **Police.** When it comes to stocking their crime-fighting arsenals, many police forces consider computers to be just as important as guns and ammunition. Today's police cruisers are equipped with laptop computers and wireless Internet connections that enable officers to search for information on criminals, crime scenes, and procedures.

Fact Check

1. The common element that makes computers so important throughout society is
   a. the central processing unit
   b. information
   c. flexibility
2. List four things a home computer might be commonly used to accomplish.
3. List three types of government agencies that use computers.

Health Care Pay a visit to your family doctor or the local hospital, and you'll find yourself surrounded by computerized equipment. Computers, in fact, are making health care more efficient and accurate while helping providers bring down costs.

Many different health care procedures now involve computers, from ultrasound and magnetic resonance imaging to laser eye surgery and fetal monitoring. Surgeons now can use robotic surgical devices to perform delicate operations and even to conduct surgeries remotely. New virtual-reality technologies are being used to train new surgeons in cutting-edge techniques, without cutting an actual patient.

But not all medical computers are so high-tech. Clinics and hospitals use standard computers to manage schedules, maintain patient records, and perform billings. Many transactions between physicians, insurance companies, and pharmacies are conducted by computers, saving health care workers time.

Green Computing Environmental impact is a familiar topic in business and personal life. Companies, governments and individuals around the world are considering the influence that their choices and actions have on the health and well-being of our planet. Green computing refers to the efforts made

Focus on the Issues

Controlling Computers with the Mind

The idea that humans could control computers with little more than their thoughts is the stuff of science fiction. Or is it?

A team of doctors, scientists, and programmers has developed a device that does exactly that. For the first time, a severely paralyzed—or "locked-in"—patient has the ability to control a computer directly with his or her thoughts.

The device, called the Brain Communicator, was created by Neural Signals, Inc., and allows a locked-in user (who is alert and intelligent but unable to move or speak due to stroke, disease, or injury) to control his or her personal computer without the need for a manual keyboard, voice recognition system, or other standard means of control. No voluntary movement is necessary.

Neural interface devices (NIDs) such as the Brain Communicator allow users to take advantage of small electrical signals generated spontaneously in the body. These signals can be obtained either directly or indirectly. Direct methods of collecting the signals involve surgical implantation in the user's body; indirect methods can utilize the user's muscle movements, eye movements, or EEG brain waves.

With NIDs, simply by imagining movement, locked-in patients can use a word processor or speech synthesizer, surf the Internet, or access environmental controls such as lights, music, and TV. Medicine and computer technology combine to open the horizons of their locked-in world.

Even as the future looks bright, the field of neural interfacing technology is still in its infancy, and the practical applications of the technology have yet to be realized. Perhaps, someday soon, personal computers will come bundled with biological signal sensors and thought-recognition software just as commonly as the word processing and educational programs of today.

Figure 1.12 Computers help in nearly all aspects of health care, from billing to controlling machines for surgeons.

toward reducing the environmental impact in the manufacture, use, and disposal of computers.

Like many products, the manufacture of computers of any size can use or produce hazardous materials. But properly handling and reducing the use of those materials is just the beginning for green computing.

The "green" philosophy includes looking at ways to reduce waste when replacing computers. Underperforming computers could be simply replaced, of course, but then the old computers are completely discarded. Instead, upgrading components as needed (for example, increasing the amount of memory or data storage capacity) may allow a computer to keep up with demand, reducing the amount that is thrown away in the process.

Computers can generate a great deal of heat, and a lot of power is used to keep them cool; fans in the case and attached to individual parts use a lot of energy, and in large computer installations air conditioning plants may be required to keep room temperature low. Green computing solutions can combine more power-efficient computer hardware with improved cooling techniques such as liquid-cooled components and improved air flow to significantly reduce power use. Even home users can reduce power usage by keeping the fans and airways of their home computers free of dust.

There are many other ways that green computing advocates work to find ways to improve the condition of our planet, from designing software programs to run more efficiently, to encouraging businesses to let some of their employees work from home, leave the car in the driveway, save gas and reduce pollution. With computers in such heavy use all around the world, even small improvements in computer efficiency can make a big difference to the pressure we place on the environment.

Social Communication As you've seen in this lesson, computers have become familiar tools in many different parts of our society. But computer technology is also having a profound effect on society itself by changing the ways we communicate. The way we interact with others, the people to whom we're connected, the frequency of communication, and the methods we now use are all startlingly different than they were twenty, ten, or in some cases just one or two years ago.

Once, if we wanted to contact a friend or colleague, we called their telephone number. If they weren't home or at their desk, we'd just have to call them back later and in the meantime, chances were good that we didn't know for sure where they were.

Now, mobile computers and smart phones provide instant access to people. Send a text message and it instantly requests attention from the receiver. Call someone's cell phone, and you rarely get silence in return.

Services have also sprung up that encourage people to constantly share their whereabouts and thoughts. Foursquare is a social software program that allows you to alert the world that you just walked into Jim's Fabulous Bakery. Twitter will help you tell your friends and followers that the place is packed, and you're going to be in line forever. Facebook lets your friends know that chocolate croissants are simply the best thing in your life right now.

In the past, you might tell a small handful of people about your divine croissant, but on Facebook and Twitter you might have dozens, hundreds, or even thousands of connections, and every one of them gets your news. On the receiving end, you get a steady stream of similar updates from everyone with which you have a connection.

Computers allow us to create and maintain intimate social connections with far more people than had ever before been possible, no matter where in the world they live. Whatever changes this may bring to our local and global cultures, computers will certainly continue to play a major role in our rapid evolution of communication.

IN Summary

- A computer is an electronic device that processes data, converting it into information that is useful to people. The two basic types of computers are analog and digital. The computers commonly used today are all digital computers.
- Computers designed for use by a single person include desktop computers, workstations, notebook (or laptop) computers, tablet computers, handheld computers, and smart phones. Other types of computers—such as network servers, mainframes, minicomputers, and supercomputers—are commonly used by organizations and support the computing needs of many users at once.
- Computers have changed the way we work, communicate, create, and play. Computers are important because information is so essential to our lives, whether that information takes the form of a news report, song, X-ray, mathematical formula, or recipe. All these kinds of information can be stored and processed by computers. As tools for working with information, and for creating new information, computers may be one of humanity's most important creations.

Key Terms

computer, 4
desktop computer, 6
digital pen, 7
docking station, 6
handheld personal computer, 7
input/output (I/O) device, 9
laptop computer, 6
mainframe, 9
microcomputer, 5
midrange computer, 9
minicomputer, 9
mobile computer, 7
netbooks, 6
network server, 8
networking, 5
notebook computer, 6
personal computer (PC), 5
personal digital assistant (PDA), 7
smart phone, 7
stylus, 7
supercomputer, 9
system unit, 6
tablet PC, 7
terminal, 9
workstation, 6

Key Terms QUIZ

Complete each statement by writing one of the terms listed under "Key Terms" in each blank.

1. The general name for a single-user computer is a(n) _____.
2. A computer designed to handle the needs and requests of thousands of users at a time is known as a(n) _____.
3. When not in use, a(n) _____ computer folds up for easy storage.

4. _____ PCs are flat computers that have a touch-sensitive screen that can accept input from a special pen or finger.
5. Though it may look like a desktop computer, a(n) _____ is a device that provides access to a mainframe computer.
6. A(n) _____ combines a cellular phone with computer programs in a single device.
7. A(n) _____ is similar in function and appearance to a smart phone, but lacks the telephone capability.
8. The special pen used with touch-sensitive computer screens is known as a(n) _____.
9. Computers can be connected together with wires or wireless technology to create a(n) _____.
10. _____ are the most powerful computers ever created, linking hundreds of thousands of smaller computer processors together.

Review QUESTIONS

In your own words, briefly answer the following questions or respond to the statements.

1. What is a computer?
2. List six types of computers designed to be used by one person at a time.
3. List four types of computers that are designed to support many users and can be accessed by multiple people at the same time.
4. What are four ways that computers can be used in a typical home?
5. How can computers improve education for people who live in remote areas where local colleges and schools are not available?
6. Describe two ways that computers can help people running small businesses.
7. In addition to helping doctors perform surgery, what are two functions in the health care industry that are aided by computers?
8. Explain what the term "green computing" means.
9. List three ways that computer technology or users can reduce the harm done to the Earth's environment.
10. Describe three ways that computers have affected the way we communicate with each other.

LESSON LAB

Complete the following exercises as directed by your instructor.

1. During the course of a normal day, keep a list of your encounters with computers of various kinds. Your list should show the place and time of the encounter, the type of interaction you had with the technology, and the results of that interaction. (Remember, computers can take many sizes and forms, so be alert to more than just PCs.) Share your list with the class.
2. Learn more about green computing. Start your computer's browser and go to Google at http://www.google.com/. Search on the term "green computing" and follow search result links to at least two of the related sites. Then, take a look at Google's own statistics for their data center efficiency at http://www.google.com/corporate/datacenter/efficient-computing/index.html and see how they compare the energy they use for searches to other common activities.

Team EXERCISE
Critical Thinking

This lesson identified many different types of computers that are used in the world today, from handheld PCs to giant, room-sized supercomputers. In this exercise, you'll revisit that topic by applying an important workplace ability: *critical thinking*, which brings together skills such as observation, interpretation, and evaluation to understand and apply information. In this case, you'll be paying closer attention to the part that computers play in the world around you and your classmates.

Before your next class session, note three different types of computers (for example, handheld, tablet, or desktop PCs) that you see being used, either by yourself or by people around you. For each type of computer, identify and record the basic tasks that are being performed.

Back in class, divide into groups of three or four. First, compare notes on commonality. Were there some types of computers that all of you found in use? Was there a kind of computer that only one person identified? If everybody found at least one type in common, was the same type of activity being performed?

Then, have each person choose one computer task that they noted and discuss whether the computer itself is a requirement to perform that task. Could the task still be accomplished without a computer, or is this a type of activity that simply did not exist before digital computers were made readily available? Create a list of these tasks and findings to share with other groups when the exercise is complete.

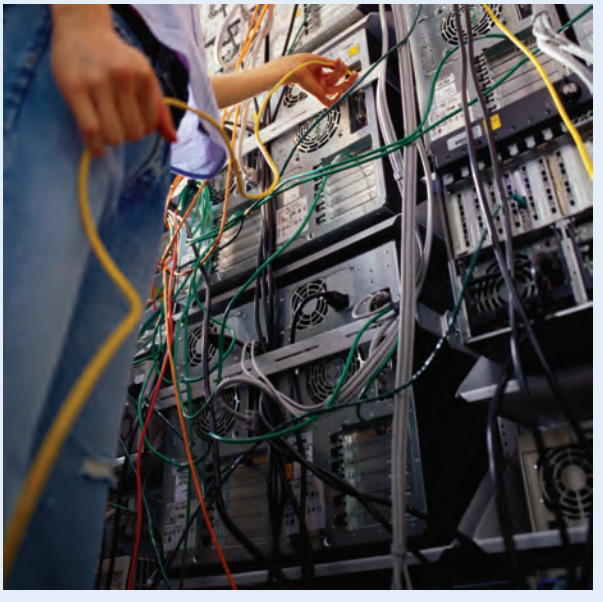
Career BUZZ

Ask Andy Yother what the best part of his job is, and his answer comes quickly: "I get to play with million-dollar toys," says this lead hardware and support engineer at Norcross, Georgia-based Canvas Systems, a reseller of certified, pre-owned IT equipment. Those toys span a wide range of technology systems and manufacturers, making Yother's job both challenging and fulfilling at the same time.

"I handle any piece of equipment that a manufacturer like Sun Microsystems or IBM would make," says Yother. "It's neat to know that during any given week I'm going to build, configure, test, and prepare for sale a wider variety of equipment than most folks will see in their entire careers."

Yother, who is currently completing his bachelor's degree in business administration at Shorter College, has racked up career experience working for PC makers and circuit board manufacturers. He started in an entry-level position at Canvas Systems, handling low-level testing and identification of systems. Today he oversees a team of six auditors and five engineers who build bare-metal assembly orders to customer specifications.

"Our customers contact us, tell us what they need, and we start with the bare bones and work up from there," says Yother, whose typical workday starts at 8 a.m. and ends at 7 p.m. or later, depending on the time of year and level of demand. "We configure the machines, test them, and prepare them for customer use."



Keeping up with changing technology is no easy task for Yother, who must know how to break down and rebuild both older systems and the newest, state-of-the-art systems available on the market. To keep up, he reads trade and technology magazines, visits manufacturers' Web sites, and subscribes to online mailing lists. "It's about trying to find the best sources of accurate information and digesting it all," says Yother. "Some days, my brain just aches from information overload."

Yother sees hardware technicians' roles increasing in the future. "We wouldn't have an IT field without the circuits, memory, and processors to back it up," says Yother, who advises all aspiring technicians to learn the computer inside and out, and to truly understand how it processes information and accomplishes tasks. Whether they're working for a company like Canvas Systems or within a firm's IT department, hardware maintenance technicians are responsible for the following kinds of tasks:

- Installing and configuring new computer hardware. Installing peripherals.
- Upgrading computers (installing updated cards, memory, drives, etc.).
- Dealing with network-related hardware issues (installing network interface cards, working with cabling, installing hubs or routers, etc.).
- Troubleshooting and repairing hardware of all types.

Many companies rely on their hardware maintenance technicians for input when planning for new system development, expansion, or acquisitions. Their input is important because technicians are in daily contact with end users and develop a good understanding of their needs. A significant advantage of the hardware technician's job is that it is a great springboard to other, more advanced careers in technology. Entry-level technicians typically earn $30,000 to $35,000, with pay scales increasing with experience to levels of $50,000 a year or more.

LESSON 1B:

Looking Inside the Computer

Most people believe computers must be extremely complicated devices because they perform such amazing tasks. To an extent, this is true. The complexity of a central processor's circuitry, layering millions of connections together in a space the size of your fingernail, is one of humankind's greatest technological triumphs. No less of a feat is the lightning-fast coordination of all the different subsystems in a computer to produce a flexible, reliable machine that its user barely notices as he or she performs tasks with it.

Yet like any machine, a computer is still a collection of parts, which are grouped according to the kinds of work they do. Although there are many, many variations on the parts themselves, there are only a few major categories. If you learn about those families of computer components and their basic functions, you will have mastered some of the most important concepts in computing. As you will see, the concepts are by and large simple and straightforward.

This lesson gives you a glimpse inside a standard desktop computer and introduces you to its most important parts. You will learn how these components work together and allow you to interact with the system. You also will discover the importance of software, without which a computer could do nothing. Finally, you will see that the user is (in most cases, at least) an essential part of a complete computer system.

1.4 The Parts of a Computer System

As you saw in Lesson 1A, computers come in many varieties, from the tiny computers built into household appliances to the astounding supercomputers that have helped scientists map the human genome. But no matter how big it is or how it is used, every computer is part of a system. A complete **computer system** is much more than just the box on the floor at your feet and the monitor on your desk. The term encompasses the four broad categories that make the machine fully useful: hardware, software, data, and the user (see Figure 1.13).

HARDWARE

The physical devices—both electronic and mechanical—that make up the computer are called **hardware**. Hardware is any part of the computer you can touch. Input and output devices, the system case, cables, and networking devices are all examples of hardware.

SOFTWARE

Software is a set of instructions that makes the computer perform tasks. In other words, software tells the computer what to do. The term **program** refers to any piece of software. Some programs exist primarily to help the computer and its subsystems perform tasks and manage their own resources. Other types of programs exist for the user, enabling him or her to perform tasks such as creating documents, playing games, using the Internet, or even writing other programs. Thousands of different programs are available for use on personal computers.

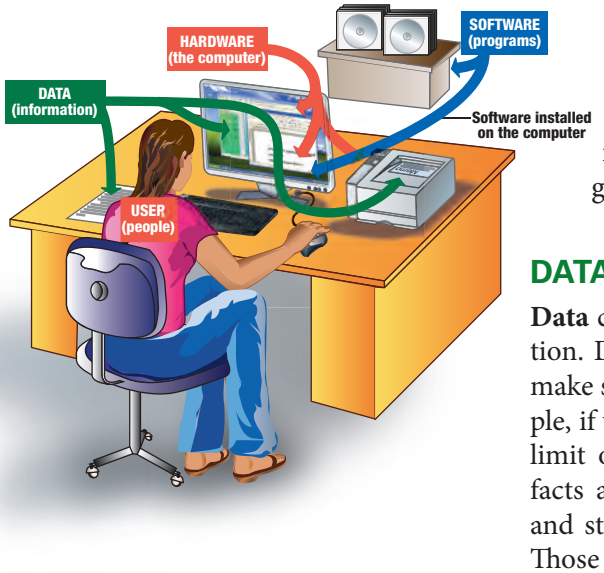


Figure 1.13 A complete computer system.

DATA

Data consist of individual facts or pieces of information. Data are specific to the task at hand and often make sense only in their intended context. For example, if you were writing a proposal to lower the speed limit on a neighborhood street, you might include facts about the average speed of cars on that road and statistics about auto speed and serious injuries. Those facts are data, and while they are relevant for your proposal, they might not be useful data when

Figure 1.14 Software turns a generic computer into just the right tool for each user.

planning recipes for this weekend's dinner party. Choosing the right data to examine and process is a big part of making the computer an effective tool.

There is a difference between information and data. Information describes concepts, facts, and ideas that people find useful. Data are raw materials that we use in the creation of information. For example, you could think of the letters of the alphabet as data. By themselves, the letters mean little; they are merely symbols. But when we put them together to form words and sentences, we produce information. Others can read the words and gain understanding of concepts and ideas.

Information can also be used as data, as you can see in the example above about auto speed and injuries. Data about speeds can produce statistical information, and that information could itself be used as data when creating presentation pictures for the proposal.

Computers require data in order for their programs, their processing tasks, to take on meaning. A program that simply adds numbers together for no purpose isn't very useful. A program that adds a list of auto speeds together in order to calculate an average is producing value for the user by helping the user create a proposal.

USERS

People are the computer operators, also known as **users**. One might argue that some computer systems are complete without a person's involvement; however, no computer is totally autonomous. Without a user, a computer would have no data to use in its calculations, and its results would be of no value because no person would put those results to use.

A computer can still have users without a person sitting in front of it at every moment. A car's diagnostic computer normally doesn't have an attentive user, but the information it saves and provides is certainly put to use at the repair shop. The repair technician is that computer's user, even though he or she is rarely present.

A direct user can also be other computers or computer components acting on behalf of people. For example, a network server (whose sole job is to route network traffic from one PC to another) communicates with client computers instead of directly with people. Even so, those client computers are ultimately there at the request or intention of people, so no useful computer is completely isolated from human contact.

THE INFORMATION PROCESSING CYCLE

Using all its parts together, a computer converts data into information by performing various actions on the data. For example, a computer might perform a mathematical operation on two numbers and then display the result. Or the computer might perform a logical operation, such as comparing two numbers, and display that result. These operations are part of a process called the **information processing cycle**, which is a series of steps the computer follows to receive data, process the data according to instructions from a program, display the resulting information to the user, and store results (see Figure 1.15).

Each step in the information processing cycle involves one or more specific components of the computer:

1. **Input.** The computer accepts data from some source, such as the user, a program, or some sort of hardware, for processing.
2. **Processing.** The computer's processing components perform actions on or with the data, based on instructions from the user or a program.
3. **Output.** The computer provides the results of its processing. Typically, the results appear as text, numbers, or a graphic on the computer's screen or as sounds from its speaker. The computer also can send output to a printer or transfer the output to another computer through a network. During the information processing

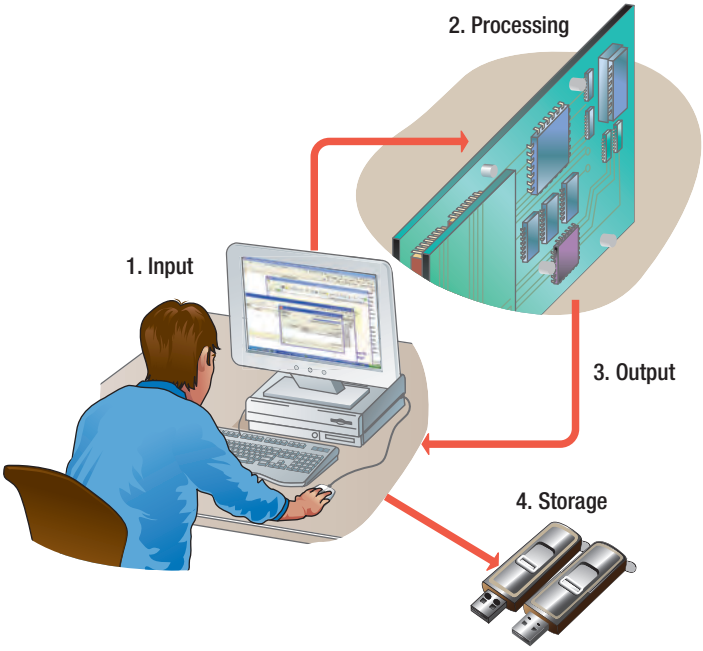


Figure 1.15 The information processing cycle.

cycle, the computer will always produce some form of output, but that output will not necessarily be noticeable for its user. Output may be stored, held for later, or used as input for new tasks without the user being aware of it.

4. **Storage.** The computer stores the results of its processing. If the computer stores output in its memory, it is usually considered temporary storage because information in memory can be lost when the computer shuts down. To store information permanently, the computer will save its output to a hard drive or some other kind of storage medium. Storage is optional and may not always be required by the user or program. (The next section discusses memory and storage devices.)

Fact Check

1. A complete computer system includes
   a. hardware, software, data, and users
   b. CPU, hard drive, keyboard, and mouse
   c. windows, Web windows, Web browser, e-mail, and word processor
2. Computer hardware
   a. is only contained within the system unit
   b. must never be plugged in when the computer is turned on
   c. is any part of the computer you can touch
3. The specific components involved in each step of the information processing cycle are
   a. hardware, software, data, and users
   b. input, processing, output, and storage
   c. hard drive, optical disk, and tape

1.5 Essential Computer Hardware

Electronic parts and subsystems in a computer are generally installed on a **circuit board**, which is commonly a thin, rigid piece of plastic or other material that provides a convenient way to mount, organize, and connect parts together. Circuit boards are usually rectangular, come in a wide variety of sizes, and have at least one kind of connector so they can be conveniently linked to other parts of the computer.

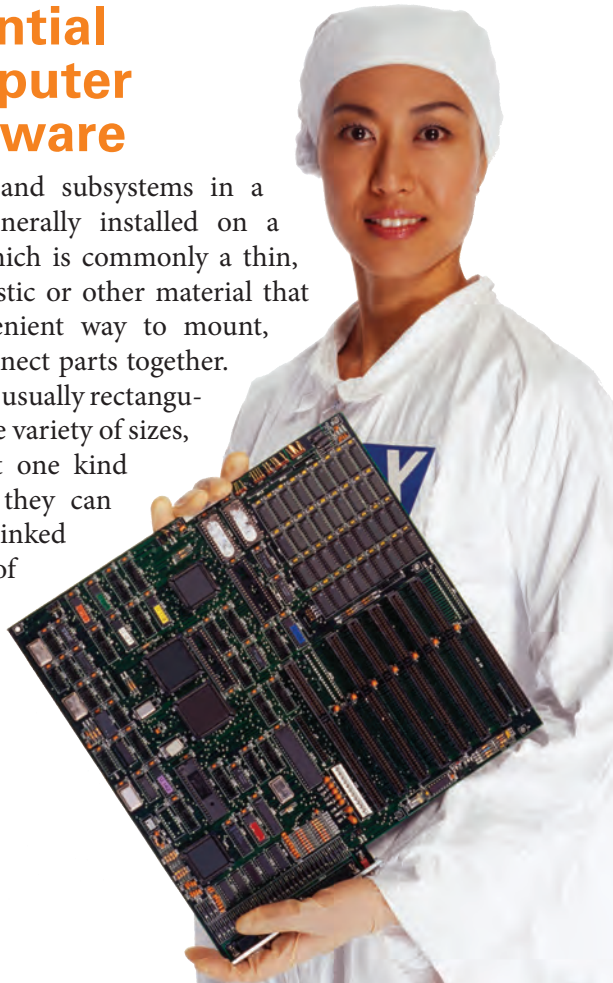


Figure 1.16 A circuit board with sets of chips installed.

Circuit boards that are used to provide a specific ability (like sound or video capability) in the computer are also commonly called **cards**.

MOTHERBOARD

A computer has several hardware subsystems that perform its required tasks. While it's common to refer to the CPU as the central part of a computer system, there is a less-mentioned hardware component that truly serves to connect everything else together: the **motherboard**. Sometimes called a mainboard, a motherboard is the largest circuit board in a personal computer. It contains connectors and ports for hooking up all the other parts of a computer, from the CPU to the webcam on top of the monitor. It also contains its own set of electronic components to help regulate power to different subsystems and manage the flow of data from one hardware subsystem to another. In some cases, the motherboard contains its own electronic subsystems that years ago were only stored on separate circuit boards, handling tasks such as video and sound output and network communication.

To be fully functional, a computer requires a set of hardware components that are connected to the motherboard. These hardware devices fall into one of four basic categories:

- Processors
- Memory
- Input and output
- Storage

While any type of computer contains these four types of hardware, this book focuses on them as they relate to the PC.

PROCESSORS

The procedure that transforms raw data into useful information is called **processing**. Logically, the computer components responsible for this procedure are called **processors**. Processors are complex electronic circuits etched into slivers of silicon.

The main processor for the computer is known as the **central processing unit (CPU)**. The CPU is like the brain of the computer; it organizes and carries out instructions that come from either the user or the software. In a personal computer, the CPU consists of a specialized chip, called a **microprocessor**, which integrates several different processing functions into a single chip.

The CPU is plugged into a special socket on the computer's motherboard. CPUs come in a wide variety of designs and processing power. By designing the CPU as an installable unit, manufacturers allow users more flexibility; computer makers can select different combinations of motherboards and CPUs, which would not be possible if CPUs were preinstalled on each motherboard.

Modern CPUs generate a great deal of heat when they operate. Without cooling, the heat would quickly damage a CPU and cause it to stop functioning. CPUs are therefore installed with cooling units that consist of large blocks of heat-conducting metal pressed tightly against the CPU and cooling fans to whisk the heat from the metal. Between the cooling unit and the mounting circuit board with dozens of tiny copper pins, the CPU looks like a very large unit, yet the chip itself is just a thin wafer a fraction of an inch across.

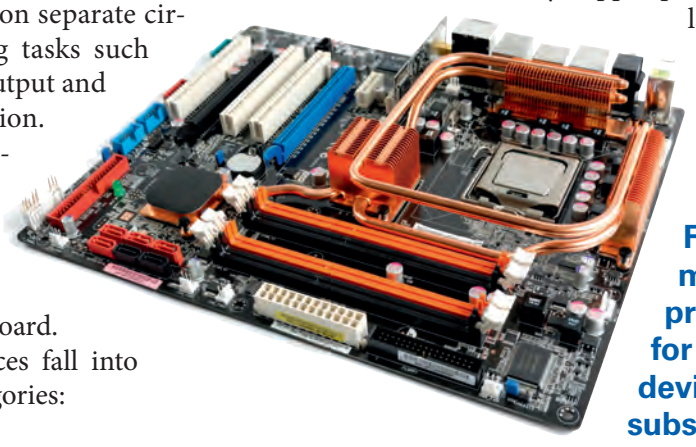


Figure 1.17 The motherboard provides connections for many different devices and subsystems.

Memory In a computer, **memory** is one or more sets of chips that store data and/or program instructions, either temporarily or permanently. Memory is a critical processing component in any computer. Personal computers use several different types of memory, but the two most important are called random access memory (RAM) and read-only memory (ROM). These two types of memory work in very different ways and perform distinct functions.

The most noticeable type of memory for a PC user is called **random access memory (RAM)**. As a result, the term *memory* is typically used to mean RAM. Like many computer components, RAM consists of a set of chips mounted on a small circuit board. Those circuit boards are plugged into sockets on the motherboard so that various subsystems can access the memory.

RAM is like an electronic scratch pad inside the computer, allowing the computer to store and retrieve

Figure 1.18 RAM for a PC comes in modules ready to be installed into the motherboard.

data and instructions very quickly. Accessing RAM is far faster than reading and writing from storage media like hard drives or DVDs. When a program is launched, it is loaded into and run from RAM. As the program needs data, it is loaded into memory for fast access.

RAM is **volatile**, meaning it loses its contents when the computer is shut off or if there is a power failure. Because RAM needs a constant supply of power to hold its data, it is not considered to be a form of permanent storage.

RAM has a tremendous impact on the computer's operating efficiency. Generally, the more RAM a computer has, the more it can do and the faster it can perform certain tasks. If the computer needs data but doesn't have enough RAM to hold what it needs, it must store some of what is in RAM already onto its hard drive in order to make more room. Storing and retrieving chunks of data on disk is very time consuming, and if the computer is following this process frequently, programs run slowly. Adding RAM to a computer system to improve its performance is one of the more common system upgrades people perform.

The most common measurement unit for describing a computer's memory is the **byte**—the amount of memory it takes to store a single character, such as a letter of the alphabet or a numeral. When referring to a computer's memory, the numbers are often so large that it is helpful to use terms such as **kilobyte (KB)**, **megabyte (MB)**, **gigabyte (GB)**, and **terabyte (TB)** to describe the values; these terms are defined in Table 2.1. Today's personal computers commonly require at least one gigabyte of memory to comfortably function for light-duty use. Many users choose to add more (four to eight gigabytes) for better performance.

RAM cards are not all created equal. Different models of RAM may have different speeds at which they store and retrieve data, different methods for data storage and retrieval, and even different physical layouts.

Each PC motherboard requires a specific type and speed range of RAM. Many older styles of RAM cannot even be physically installed on newer motherboards because their connectors are a different size and shape. But even if a RAM card can be plugged in, an incompatible data transfer speed or method can result in terrible performance or—more likely—a completely nonfunctional computer. Whether building a computer from scratch or upgrading an existing system's RAM, it is critically important to match the RAM card's specifications to the requirements provided by the motherboard manufacturer. When adding extra RAM to a system, it's also important to make sure the existing and new RAM modules match in speed in order to avoid poor performance (or no performance at all).

Read-only memory (ROM) permanently stores its data, even when the computer is shut off. It is used not for programs and user data but, rather, to store computer instructions and hardware information that rarely changes. Though ROM's contents can be changed, the

TABLE 1.1 UNITS OF MEASURE FOR COMPUTER MEMORY AND STORAGE

Unit	Abbreviation	Approximate Value (bytes)	Actual Value (bytes)
Kilobyte	KB	1,000	1,024
Megabyte	MB	1,000,000 (1 million)	1,048,576
Gigabyte	GB	1,000,000,000 (1 billion)	1,073,741,824
Terabyte	TB	1,000,000,000,000 (1 trillion)	1,099,511,627,776

process is much slower than for altering RAM, and that makes ROM unsuitable for storing temporary or rapidly changing information. ROM is called **nonvolatile** memory because it never loses its contents.

INPUT AND OUTPUT DEVICES

A personal computer would be useless if you could not interact with it, because the machine could not receive instructions or deliver the results of its work. *Input devices* accept data and instructions from the user or from another computer system. Examples include keyboards, mice, and digital cameras. *Output devices*, including the monitor, printer, and speakers, return processed data to the user or to another computer system. The computer sends output to the monitor (the display screen) when the user needs only to see the output. It sends output to the printer when the user requests a paper copy—also called a *hard copy*—of a document.

Some types of hardware can act as both input and output devices. For users, a touch screen displays output in the form of text or icons you can touch, and it accepts input via special sensors on the screen to detect the touch of a finger. Between two computers, the most common types of devices that can perform both input and output are **communications devices**. These devices connect one computer to another—a process known as networking. Such hardware devices typically are one of two types (both of these will be discussed in greater detail later in this chapter):

1. A **modem** converts in both directions between digital data the computer understands and analog signals that are transmitted over telephone or cable television wires.
2. **Network interface cards (NICs)** are digital-to-digital hardware components that both allow communication and can uniquely identify the computing device on the network.

STORAGE DEVICES

A computer can function with only processing, memory, input, and output devices. To be really useful, however, a personal computer also needs a place to keep program files and related data when they are not in use. The purpose of **storage** is to hold data permanently, even when the computer is turned off.

You could think of storage as an electronic file cabinet and RAM as an electronic worktable. When you need to work with a program or a set of data, the computer locates it in the file cabinet and puts a copy on the table. After you have finished working with the program or data, you put it back into the file cabinet. The changes you make to data while working on it replace the original data in the file cabinet (unless you store it in a different place).

The main types of computer storage are magnetic, optical, and flash memory. The most common type is the **magnetic disk**. A disk is a round, flat object that spins around its center. (Magnetic disks are almost always housed inside a case of some kind, so you can't see the disk itself unless you open the case.) **Read/write heads**, which work in much the same way as the heads of a tape recorder or VCR, read data from the disk or write data onto the disk. The complete device that holds a disk is called a **disk drive**.

In addition to magnetic storage, nearly every computer sold today includes at least one form of **optical storage**—devices that use lasers to read data from or write data to the reflective surface of an optical disc. For a time, the **CD-ROM drive** was the most common type of optical storage device, but it has lately been surpassed by the use of DVD drives, which in turn are rapidly losing ground to the new Blu-ray optical storage format. **Compact discs (CDs)** are a type of optical storage, identical to audio CDs. Data CDs can hold varying amounts of data up to nearly 900 MB. **CD-Recordable (CD-R)** disks allow you to create your own CDs, but CD-R disks cannot be erased and reused. A **CD-ReWritable (CD-RW)** disk allows you to write and erase data multiple times on the same disk.

The **digital video disc (DVD)**, which is familiar if you rent movies for home viewing, is used not just for home theaters but personal computers as well. Using sophisticated compression technologies, the typical single-sided DVDs can hold anywhere from 4.7 GB to 8.5 GB of data. Though this capacity is still far less

Figure 1.19 A peek inside a hard drive shows a round platter and one of the read/write heads.

than the capacity of a hard disk, DVDs are popular for permanent, removable storage.

Modern DVD drives for computers are combination units, capable of reading from and writing to both DVDs and CDs, freeing the user from the need to purchase different drives for each type of disk. With just one drive, users can install programs and data from their standard DVDs and CDs as well as listen to music and watch movies on their personal computers.

The latest advance in optical storage technology is called the **Blu-ray disc**, named after the blue-spectrum laser that the drive uses. Though the disc's diameter is the same as for CD and DVD drives, switching to a blue light laser and improving the design of the disc itself have resulted in a storage format that can store 25 to 50 GB of data depending on whether one or two storage layers are in use. The newest Blu-ray storage formats allow for more than 100 GB to be written to a single disc. Blu-ray drives are rapidly becoming the new standard for both home entertainment media and permanent data storage and are included in many home theater, game console, and computer systems. Most Blu-ray devices can also read CD and DVD disks.

The future of data storage may well be the **solid state drive (SSD)**, a memory subsystem that relies on special kinds of ROM to permanently store data. Since SSDs use memory chips for storage, they have no moving parts like hard disks; consequently, they have no risk of losing data due to mechanical failures, and they generally use less power in their operation. Their lack of mechanical parts also results in a smaller size, which along with reduced power requirements makes them an ideal match for mobile computing devices like notebook computers.

Though most PCs still use a hard drive, you may very well have recently been using an SSD without using the term. **Flash drives**, commonly found as the little storage sticks that plug into a USB port, are a regular staple of many computer users. Once used to transfer occasional files between computers, flash drives are now produced with enough storage to rival hard drives, with recent models providing 256 GB of storage. This allows users to store entire music and video libraries in one small package, or back up their PC's hard drive to a device that can be easily secured in a different location.

Also included in the SSD category are the small, thin memory cards used to store data in portable devices such as digital cameras and phones. The two major formats currently in use for these devices are **CompactFlash (CF)** and **Secure Digital (SD)**, and manufacturers for each of those formats produce a range of cards in different sizes and storage capacities. It's common to find SSD cards that provide anywhere from 2 to 32 GB of storage, but both CF and SD formats are expanding to support storage amounts into the terabytes and beyond.

Figure 1.20 Solid state drives have no moving parts; perfect for small devices with limited power.

CF and SD cards require little power to run, which makes them ideal choices for storage in devices that rely on limited battery capacity to operate. They can be easily removed from their home device and transferred to a special reader on a PC, to allow the quick transfer of images or video from the mobile device to the PC.

Though SSD technology has been commercially available since the 1970s, it is rapidly evolving. Costs are

Fact Check

1. What is the purpose of storage?
   a. Ensuring the user's workspace is kept neat and tidy
   b. Holding data permanently, even when the computer is turned off
   c. Freeing up resources for the CPU
2. A microprocessor
   a. must be isolated from the other hardware subsystems
   b. integrates several different processing functions into a single chip
   c. is actually surprisingly large

falling even as design improvements are increasing the efficiency of the devices. It may not be long before hard drives cease to be a common component of desktop PCs and notebooks.

1.6 Software Brings the Machine to Life

The set of instructions that enable a computer to perform specific tasks is generically called a program or software. These instructions tell the machine's hardware components what to do; without a program, a computer could not do anything at all. When a computer uses a particular program, it is said to be **running** or **executing** that program.

Most programs that run on a computer are not built directly into the computer system. This allows different users to customize their computer to ideally suit their needs. To make software available to the computer, it is **installed**, which means that the program is written into the computer's permanent storage. For all but the simplest of programs, installation also usually includes adding references to the new program into the computer's operating system, so that the operating system will know where to find the program, and how to start it.

Installation may also include many other tasks, such as the creation and placement of data files for the program to use, establishing connections to devices such as printers for the new software to use, and updating software modules in other programs that are required by the new software. With few exceptions, the installation of software for consumer devices such as PCs and smart phones is automatic, requiring little else from the user than permission to perform the installation.

Although the array of available programs is vast and varied, most software falls into two major categories: system software and application software.

System software is any program that controls the computer's hardware or can be used to maintain the computer in some way so it runs more efficiently. There are four basic types of system software:

1. **Firmware** is used to directly control hardware devices, such as keyboards, hard drives, and memory cards.[1] Firmware can also be found outside of a personal computer; the programs that control your TV remote and cell phone would be considered firmware as well. Firmware is embedded on microchips and placed on the device that it controls.
2. An *operating system* tells the computer how to use its own components. An operating system is essential for any computer, because it acts as an interpreter between the hardware, application programs, and the user. Three of the most common operating systems are Microsoft's Windows, Apple Computer's Mac OS X, and Linux.
3. A **network operating system** allows computers to communicate and share files and device resources across a network while controlling network operations and overseeing the network's security.
4. A **utility** is a program that makes the computer system easier to use or performs highly specialized functions. Utilities are used to manage disks, troubleshoot hardware problems, and perform other tasks that the operating system itself may not be able to do.

Application software tells the computer how to accomplish specific tasks, such as word processing or drawing, for the user. Thousands of applications are available for many purposes and for people of all ages. Table 1.2 identifies major categories of applications and describes how they are most commonly used.

Though application software performs user-oriented tasks, it must still be created with hardware and the operating system in mind. A game designed for an Apple computer, for example, will not run on Sony's Playstation 3 game console without significant modification. Not only are the operating system and hardware completely different, but the fundamental way that people use the two machines are also worlds apart. A game console user typically controls the software's actions through a small set of buttons or by simply moving a controller pad through the air. A desktop computer substitutes a keyboard and mouse

Fact Check

1. Which type of software is a word processor program?
   a. An operating system
   b. Firmware
   c. Application software
2. List the four types of system software.

[1] R. Kayne (2010), What is firmware? *WiseGEEK*. Retrieved May 22, 2010, from http://www.wisegeek.com/what-is-firmware.htm

TABLE 1.2 MAJOR CATEGORIES OF APPLICATION SOFTWARE

Type	Purpose
Document publishing	Creating text-based documents such as newsletters, reports, articles, and brochures
Spreadsheets	Creating numeric-based documents such as budgets or balance sheets
Database management	Building and manipulating large sets of data, such as the names, addresses, and phone numbers in a telephone directory
Presentation	Creating and presenting electronic slides
Graphics	Designing illustrations or manipulating photographs, movies, or animations
Multimedia authoring	Composing music and building digital movies that incorporate sound, video, animation, and interactive features
Business software	Managing inventories, client contacts, sales databases, and accounting
Education software	Teaching subjects to children and adults, groups or individual learners
Internet applications	Designing Web sites, surfing the Web, sending e-mail, and much more
Games	Playing single-player or multiplayer games ranging from the simple to dazzlingly complex strategic games hosted on the Internet

for joysticks, triggers and colored buttons, and may assign commands and controls to a wide array of keys that the controller simply doesn't have.

As hardware changes, software may also need to adapt in order to operate efficiently. For example, when manufacturers began producing multi-core processors—microprocessors containing more than one CPU—application software could not take advantage of the extra computing power without making changes to distribute the program's work to the different CPUs.

It is not always necessary for all application software to reside on the user's machine. It is common today for part or all of a program to be provided to users via a local network or the Internet. For example, Google's Google Docs service allows users to create documents such as letters and spreadsheets using online editors, and store the data on Google's servers instead of their own computers. This allows many users to access and update those documents in real time, and collaborate and coordinate their work at a central location without the need to buy software and maintain special servers. It's an ideal solution when team members for a project may participate from all around the world.

1.7 Data and Users

Hardware and software together create a functional computer, but all computers require data in order to become useful. Without data to process and information to create or deconstruct, a computer has no value. Data serves as the computer's raw material for performing every task.

Personal computers are designed to work with a human user. In fact, the user is a critical part of a complete computer system, especially when a personal computer is involved. This may seem surprising, since it's easy to think of computers as intelligent devices that can do practically anything. People also sometimes believe computers can think and make decisions, as humans do, but this is not the case. Even the most powerful supercomputers require human interaction—if for no other reason than to get them started and tell them which problems to solve.

COMPUTER DATA

The computer is a tool that aids in that process of converting data to information. A computer processes and manipulates everything as data. All letters, numbers, sounds, pictures, and even its software are reduced to strings of digits; hence the terms "digitize" and "digital." It accepts the data it has been given, processes its instructions in a strict sequence, modifies or replaces data as required by the instructions, and returns its result to the user. The computer's software is ultimately responsible for completing the conversion from data to information by displaying the results of the computer's activity in a way that is meaningful for the user.

Within the computer, data is organized into **files**. A file is simply a set of data that has been grouped together and given a name. A file that the user can open and use is often called a **document**. Although many people think of documents simply as text, a computer document can include many kinds of data. For example, a computer document can be a text file (such as a letter), a group of numbers (such as a budget), a video clip (which includes images and sounds), and so on. Programs are organized into files as well; these files contain the instructions and data that a program needs in order to run and perform tasks.

THE USER'S ROLE

When working with a personal computer, the user can take on several roles, depending on what he or she wants to accomplish:

- **Setting up the system.** Have you ever bought a new PC? When you got it home, you probably had to unpack it, set it up, and make sure it worked as expected. If you want to change something about the system, you will likely do it yourself, whether you want to add a new hardware device, change the way programs look on your screen, or customize the way a program functions.
- **Installing software.** Although your new computer probably came with an operating system and some applications installed, you need to install any other programs you want to use. This may involve loading software from a disk or downloading it from a Web site. Either way, it is usually the user's responsibility to install programs, unless the computer is used at a school or business. In that case, a system administrator or technician is more likely to do the job.
- **Running programs.** Whenever your computer is on, several programs are running in the background, including the software that runs your mouse, network connections, and anti-malware protection. Such programs do not need any user input; in fact, you may not even be aware of them. But for the most part, if you want to use your computer to perform a task, you need to launch and run the software that is designed for the task, and work with it to make sure it gives you the results you want.
- **Managing files.** As you have already learned, a computer saves data in files. If you write a letter to a friend, you can save it as a file, making it available to open and use again later. Pictures, songs, and other kinds of data are stored as files. But it is the user's job to manage these files. Managing files means setting up a logical system for storing them on the computer and knowing when to delete files, move them, or copy them to a storage device for safekeeping.
- **Maintaining the system.** System maintenance does not necessarily mean opening the PC and fixing broken parts, as you would repair a car's

Figure 1.21 Computers display data in ways that help viewers learn new things.

Figure 1.22 Users put together their own choices for hardware and software to build a computer tailored to their needs.

engine. But it could! In that case, you might call a qualified technician to do the job or roll up your sleeves and tackle it yourself. In most cases, however, PC maintenance generally means running utilities that keep the disks free of clutter and ensure that the computer is using its resources efficiently.

"USERLESS" COMPUTERS

Many kinds of computers require no human interaction once they have been programmed, installed, and started up. For example, if you own a car built within the past decade, it almost certainly has an on-board computer that controls and monitors engine functions. Many new home appliances, such as washers and dryers, have built-in computers that monitor water usage, drying times, balance, and other operations. Sophisticated userless computers operate security systems, navigation systems, communications systems, and many others.

Userless computers are typically controlled by their operating systems. In these devices, the operating system may be installed on special memory chips rather than a disk. The operating system is programmed to perform a specific set of tasks. These systems are not set up for human interaction, except as needed for system configuration or maintenance.

But even without a person directly controlling and receiving output from them, these systems still have users. A computer that monitors the temperature in a refrigerator has an indirect user in the owner who is counting on the milk staying fresh for as long as possible. No useful computer is completely separated from human users.

Fact Check

1. What is the difference, if any, between data and information?
   a. Data is the raw material used in the creation of information.
   b. Data is smaller than information.
   c. Data and information are essentially the same.
2. What is the relationship between data and a computer file?
   a. Files can only hold information, not data.
   b. A file is the smallest unit of data on a computer.
   c. A file is a set of data that has been grouped together and given a name.
3. Which of the following is a role of the user?
   a. Auditing firmware
   b. Installing software
   c. Processing data

Figure 1.23 Newer cars contain onboard computers designed to monitor and control the engine with only occasional user contact.

IN Summary

- A complete computer system includes hardware, software, data, and users. To manipulate data, the computer follows a process called the information processing cycle, which includes data input, processing, output, and storage.
- A computer's hardware devices fall into four categories: processing, memory, input and output (I/O), and storage.
- The set of instructions that enable a computer to perform specific tasks is generically called a program or software. There are four basic types of system software: firmware, operating system, network operating system, and utility.
- There is a difference between information and data. The computer is a tool that aids in that process of converting data to information. Personal computers are designed to work with a human user. In fact, the user is a critical part of a complete computer system.

Key Terms

application software, 27
Blu-ray disc, 26
byte, 24
cards, 23
CD-Recordable (CD-R), 25
CD-ReWritable (CD-RW), 25
CD-ROM drive, 25
central processing unit (CPU), 23
circuit board, 22
communications devices, 25
compact discs (CDs), 25
CompactFlash (CF), 26
computer system, 20
data, 20
digital video disc (DVD), 25
disk drive, 25
document, 29
executing, 27
file, 29
firmware, 27
flash drives, 26
gigabyte (GB), 24
hardware, 20
information processing cycle, 21
installed, 27
kilobyte (KB), 24
magnetic disk, 25
megabyte (MB), 24
memory, 23
microprocessor, 23
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motherboard, 23
network interface cards (NICs), 25
network operating system, 27
networking, 25
nonvolatile, 25
optical storage, 25
processing, 23
processors, 23
program, 20
random access memory (RAM), 23
read-only memory (ROM), 24
read/write heads, 25
running, 27
Secure Digital (SD), 26
software, 20
solid state drive (SSD), 26
storage, 25
system software, 27
terabyte (TB), 24
users, 21
utility, 27
volatile, 24

Key Terms QUIZ

Complete each statement by writing one of the terms listed under "Key Terms" in each blank.

1. A complete _____ refers to the combination of hardware, software, data, and people.
2. A(n) _____ is a set of data or program instructions that has been given a name.
3. A(n) _____ is a device that holds a disk.

4. Electronic instructions that tell the computer's hardware what to do are known as _____.
5. A rectangular card containing microchips is known as a(n) _____.
6. Data and program instructions are temporarily held in _____ while the processor is using them.
7. The _____ includes four stages: input, processing, output, and storage.
8. One _____ is roughly equivalent to 1 million bytes of data.
9. Operating systems fall into the category of _____ software.
10. In a magnetic disk drive, a special device called the _____ reads data from and writes data to a disk's surface.

Review QUESTIONS

In your own words, briefly answer the following questions or respond to the statements.

1. List the four parts of a complete computer system.
2. What are the four phases of the information processing cycle?
3. Identify four categories of computer hardware.
4. Describe the basic purpose of the central processing unit (CPU).
5. List four units of measure for computer memory and storage, not including the byte.
6. Name and differentiate the three main categories of storage devices.
7. Name and differentiate the two main categories of computer software.
8. What is the difference between data and information?
9. What is a fundamental difference between data and programs?
10. List five tasks a user may be responsible for when working with a personal computer.

LESSON LAB

Complete the following exercises as directed by your instructor.

1. What type of computer system do you use in class or in the lab? If your computer is running Windows 7, you can access this information from the Start Menu. Select "Control Panel," and from that window double-click the "System" icon. From that window, you can see the type of processor, its speed and the number of cores it has. You'll also see the amount of RAM installed in the computer, and the version of Windows 7 that is installed.

Then, in the bottom left corner of that "System" window, click on the link that says, "Performance Information and Tools." You will see a rating provided by Windows of the relative power of the computer's main subsystems, using a scale of 1.0 to 7.9. What subsystems received the lowest and highest values on your computer?

2. What kind of software is installed on your computer? To find out, all you have to do is turn on your computer. After it starts, you should see a collection of icons—small pictures that represent the programs and other resources on your computer. List the icons that appear on your screen and the names of the software programs they represent.

Team EXERCISE Diversity

Most workplaces bring together people of varying ages and physical abilities. For example, even in a workplace where no one would meet the definition of "disabled," there are likely to be individuals who wear glasses or contact lenses, and perhaps some older workers who don't read small type as well as they once did. Fortunately, today's computers typically can be customized to meet the needs of a physically diverse workforce. In this exercise, you will explore some of these capabilities.

Divide into groups of three or four. Each group will work on this exercise at one shared computer. On a sheet of paper, list the group members' names, ages, and whether or not they use glasses, contact lenses, or some other vision correction.

Using your computer and an Internet connection, visit the Web site of the Bureau of Labor Statistics (www.bls.gov). From the list of Economic News Releases, choose a news release about major economic indicators to download in PDF format. When the document is displayed, notice the zoom feature in the toolbar of icons above the document: a button with a minus sign, one with a plus sign, and a percentage. Give each group member a turn to read a paragraph of the text and adjust the document size by clicking on the plus and minus buttons or changing the display percentage. Record the preferred display percentage for each person.

Option: If you are able to save the document you downloaded and open it with Adobe Reader, do that, and then use the software's document-reading function. Highlight a paragraph of the document with your cursor. Then, in the toolbar, click on "View," and select first "Read Out Loud" and then "Activate Read Out Loud." Listen to the computerized voice read the paragraph. On your list, note whether each group member found listening helpful or unhelpful. Then deactivate "Read Out Loud," using the same drop-down menu.

Were the preferences the same for all group members? If not, what variations did you observe? Be ready to compare your group's experience with that of the other groups in a class discussion.

Chapter LABS

1. The race to build a faster computer is never ending. Find out who is currently making the world's fastest supercomputer. Open your computer's Web browser, visit a search engine site such as Google (http://www.google.com) or Bing (http://www.bing.com) and search for the phrase *world's fastest supercomputer*. Look through the search results for recent news stories, and follow links to news or encyclopedia sites that have the latest information. If your search results contain too many stories about old computers, try including the current year in your search phrase *(world's fastest supercomputer 2011*, for example). Read the article and compare how much more processing power the new computer provides over the previous record holder.
2. Explore some free services that help you use computers and the Internet to share information and creativity.
   a. Learn more about starting your own blog. Using a Web browser, navigate to http://www.blogger.com/. From the front page, click the *quick tour* link to read information about the service and what it does. You can also follow the *video tutorial* link to a YouTube video that gives you details about how to set up and start posting to a blog.
   b. Read about starting a new Web site. Use your browser to visit http://www.webs.com/. Near the bottom of the front page, follow the *View Features* button to learn more about what services are offered for free and for a fee, and get a feel for the different ways that Web sites can quickly be constructed for new users.
   c. Investigate wiki software to see how people with a common interest can share information about that subject. Go to http://www.wikia.com/ and explore some of the wiki sites that have been created. You can do this either by clicking the Random Wiki button near the top of the screen to jump to one of the thousands of wikis that Wikia hosts; or you can type a subject (for example, a favorite TV show, computer game or hobby) in the nearby search box and search for a wiki on that subject. Look through a couple of wikis to see how information is organized, and how thoroughly or superficially the subject is covered.
3. Replacing or adding RAM modules is a common operation that many home users do themselves. Learn more about this process by watching a tutorial online. With a browser, visit http://www.youtube.com/ and search on the phrase *install ram desktop*; you will most likely see a long list of results for this query. Pick one or two videos from the list to watch. If you pick a tutorial that was posted within the last year or two, you'll probably see the inside of a computer that is similar to what you might purchase today. But older demonstrations still show the same basic concept; the process of installing RAM has been the same for many years.

Think AND DISCUSS

As directed by your instructor, discuss the following questions in class or in groups.

1. Home computers are used more extensively than ever for tasks such as banking, investing, shopping, and communicating. Do you see this trend as having a positive or a negative impact on our society and economy? Do you plan to use a computer in these ways? Why or why not?

2. With the exploding popularity in tablet and handheld PCs, do you think those devices are likely to replace (or at least greatly reduce the number of) desktop PCs being used in the future? Why or why not? What factors would contribute to the desktop PC's demise; or, what factors will ensure its future survival?

FACT CHECK ANSWERS

1A:

LO1.1 What Is a Computer?

1: b. analog and digital
2: b. they process all their data and instructions as numbers

LO1.2 Types of Digital Computers

1: a. Desktop computer
2: network servers, mainframes, minicomputers, supercomputers

LO1.3 Computers in Society

1: b. information
2: Communication; business work at home; schoolwork; entertainment; creativity; personal finances; shopping; education.
3: Census bureau; Internal Revenue Service; military; police

1B:

LO1.4 The Parts of a Computer System

1: a. hardware, software, data, and users
2: c. is any part of the computer you can touch
3: b. input, processing, output, and storage

LO1.5 Essential Computer Hardware

1: b. Holding data permanently, even when the computer is turned off
2: b. integrates several different processing functions into a single chip

LO1.6 Software Brings the Machine to Life

1: c. Application software
2: firmware, operating system, network operating system, utility

LO1.7 Data and Users

1: a. Data is the raw material used in the creation of information.
2: c. A file is a set of data that has been grouped together and given a name.
3: b. Installing software