INTRODUCTION to INFORMATION TECHNOLOGY Your Digital World

Chapter Topics & Key Questions

I.1 **The Practical User: How Becoming Computer Savvy Benefits You** What does being *computer savvy* mean, and what are its practical payoffs?

I.2 **Information Technology & Your Life: The Future Now** What is information technology, and how does it affect education, health, money, leisure, government, and careers?

I.3 **Infotech Is All-Pervasive: Cellphones, Email, the Internet, & the E-World** How does information technology facilitate email, networks, and the use of the internet and the web; what is the meaning of the term *cyberspace?*

I.4 **The "All-Purpose Machine": The Varieties of Computers** What are the five sizes of computers, and what are clients and servers?

I.5 **Understanding Your Computer: How Can You Customize (or Build) Your Own PC?** What four basic operations do all computers use, and what are some of the devices associated with each operation? How does communications affect these operations?

I.6 **Where Is Information Technology Headed?** What are three directions of computer development and three directions of communications development?

If you are under the age of 30, you live in a world quite different from that of your parents and grandparents.

You are a member of the "Always On" generation, accustomed to spending 8 hours or more a day looking at various screens—on cellphones, on computers, on TVs.[1] You are a "digital native," as one anthropologist put it, constantly busy with text messaging, email, and the internet.[2] If you are an 18-to-24-year-old, you generally watch the smallest amount of live TV (3½ hours a day) compared to any other age group but spend the most time text messaging (29 minutes a day) and watch the most online video (5½ minutes a day).[3]

What are the developments that have encouraged these kinds of behavior? The answer is *information technology.* Of the top 30 innovations of the last 30 years, according to a 2009 panel of judges at the University of Pennsylvania's Wharton School, *most were related to information technology.*[4] The first four items on the list, for example, are the internet, broadband, and the World Wide Web; PC and laptop computers; mobile phones; and email. *(● See Panel 1.1.)* Unlike previous generations, you live in a world of *pervasive computing* or *ubiquitous computing.*

Central to this concept is the internet—the "Net," or "net," that sprawling collection of data residing on computers around the world and accessible by high-speed connections. Everything that presently exists on a personal computer, experts suggest, will move onto the internet, giving us greater mobility and wrapping the internet around our lives.[5] So central is the internet to our existence, in fact, that many writers are now spelling it without the capital

panel 1.1

Top innovations of the last 30 years.
The majority (23 of the 30) are in the field of information technology.*

1. Internet, broadband, World Wide Web
2. PC and laptop computers
3. Mobile phones
4. Email
5. DNA testing and sequencing
6. Magnetic resonance imaging
7. Microprocessors
8. Fiber optics
9. Office software
10. Laser/robotic surgery
11. Open-source software
12. Light-emitting diodes
13. Liquid crystal display
14. GPS devices
15. E-commerce and auctions
16. Media file compression
17. Microfinance
18. Photovoltaic solar energy
19. Large-scale wind turbines
20. Internet social networking
21. Graphic user interface
22. Digital photography
23. RFID and applications
24. Genetically modified plants
25. Bio fuels
26. Bar codes and scanners
27. ATMs
28. Stents
29. SRAM flash memory
30. Anti-retroviral treatment for AIDS

*To be more than just a new invention, an event was defined as an innovation if it created more opportunities for growth and development and if it had problem-solving value.

Source: Adapted from "A World Transformed: What Are the Top 30 Innovations of the Last 30 Years?" *Knowledge@Wharton,* February 18, 2009, *http://knowledge.wharton.upenn.edu/article.cfm?articleid=2163* (accessed May 28, 2009).

"I"—*Internet* becomes *internet,* just as *Telephone* became *telephone*—because both systems belong not to just one owner but to the world. We will follow this convention in this book.

In this chapter, we begin by discussing how becoming computer savvy can benefit you and how computing and the internet affect your life. We then discuss cellphones, the internet, the World Wide Web, and other aspects of the e-world. Next we describe the varieties of computers that exist. We then explain the three key concepts behind how a computer works and what goes into a personal computer, both hardware and software. We conclude by describing three directions of computer development and three directions of communications development.

"Just keeping busy." Multiple electronic devices allow people to do multiple tasks simultaneously—multitasking.

I.1 THE PRACTICAL USER: How Becoming Computer Savvy Benefits You

What does being computer savvy *mean, and what are its practical payoffs?*

There is no doubt now that for most of us information technology is becoming like a second skin—an extension of our intellects and even emotions, creating almost a parallel universe of "digital selves." Perhaps you have been using computers a long time and in a multitude of ways, or perhaps not. In either case, this book aims to deliver important practical rewards by helping you become "computer streetwise"—that is, computer savvy. **Being *computer savvy* means knowing what computers can do and what they can't, knowing how they can benefit you and how they can harm you, knowing when you can solve computer problems and when you have to call for help.**

Among the practical payoffs are these:

YOU WILL KNOW TO MAKE BETTER BUYING DECISIONS No matter how much computer prices come down, you will always have to make judgments about quality and usefulness when buying equipment and software. In fact, we start you off in this chapter by identifying the parts of a computer system, what they do, and about how much they cost.

Competence. To be able to choose a computer system or the components to build one, you need to be computer savvy.

YOU WILL KNOW HOW TO FIX ORDINARY COMPUTER PROBLEMS Whether it's replacing a printer cartridge, obtaining a software improvement ("patch" or "upgrade"), or pulling photos from your digital camera or camera cellphone, we hope this book gives you the confidence to deal with the continual challenges that arise with computers—and know when and how to call for help.

YOU WILL KNOW HOW TO UPGRADE YOUR EQUIPMENT & INTEGRATE IT WITH NEW PRODUCTS New gadgetry and software are constantly being developed. A knowledgeable user learns under what conditions to upgrade, how to do so, and when to start over by buying a new machine.

YOU WILL KNOW HOW TO USE THE INTERNET MOST EFFECTIVELY The sea of data that exists on the internet and other online sources is so great that finding what's best or what's really needed can be a hugely time-consuming activity. We hope to show you the most workable ways to approach this problem.

YOU WILL KNOW HOW TO PROTECT YOURSELF AGAINST ONLINE VILLAINS The online world poses real risks to your time, your privacy, your finances, and your peace of mind—spammers, hackers, virus senders, identity thieves, and companies and agencies constructing giant databases of personal profiles—as we will explain. This book aims to make you streetwise about these threats.

YOU WILL KNOW WHAT KINDS OF COMPUTER USES CAN ADVANCE YOUR CAREER Even top executives now use computers, as do people in careers ranging from police work to politics, from medicine to music, from retail to recreation. We hope you will come away from this book with ideas about how the technology can benefit you in whatever work you choose.

Along the way—in the Experience Boxes, Practical Action Boxes, Survival Tips, and More Info!s—we offer many kinds of practical advice that we hope will help you become truly computer savvy in a variety of ways, large and small.

more info!

From now on, whenever you see the **more info!** icon (above) in the margin, you'll find information about internet sites to visit and how to search for terms related to the topic just discussed.

I.2 INFORMATION TECHNOLOGY & YOUR LIFE: The Future Now

What is information technology, and how does it affect education, health, money, leisure, government, and careers?

This book is about computers, of course. But not just about computers. It is also about the way computers communicate with one another. When computer and communications technologies are combined, the result is *information technology,* or "infotech." ***Information technology (IT)*** **is a general term that describes any technology that helps to produce, manipulate, store, communicate, and/or disseminate information.** IT merges computing with high-speed communications links carrying data, sound, and video. Examples of information technology include personal computers but also new forms of telephones, televisions, appliances, and various handheld devices.

The Two Parts of IT: Computers & Communications

How do I distinguish computer technology and communications technology?

Note that there are two important parts to information technology—computers and communications.

COMPUTER TECHNOLOGY You have certainly seen and, we would guess, used a computer. Nevertheless, let's define what it is. **A *computer* is a programmable, multiuse machine that accepts data—raw facts and figures—and processes, or manipulates, it into information we can use,** such as summaries, totals, or reports. Its purpose is to speed up problem solving and increase productivity.

COMMUNICATIONS TECHNOLOGY Unquestionably you've been using communications technology for years. ***Communications technology*****, also called *telecommunications technology*, consists of electromagnetic devices and systems for communicating over long distances.** The principal examples are telephone, radio, broadcast television, and cable TV. In more recent times, there has been the addition of communication among computers—which is what happens when people "go online" on the internet. In this context, ***online***

means using a computer or some other information device, connected through a network, to access information and services from another computer or information device. A *network* is a communications system connecting two or more computers; the internet is the largest such network.

Information technology is already affecting your life in exciting ways and will do so even more in the future. Let's consider how.

Education: The Promise of More Interactive & Individualized Learning

How is information technology being used in education?

In her physics classes at the Massachusetts Institute of Technology, professor Gabriella Sciolla's high-tech classroom has white boards and huge display screens instead of blackboards. The professor can make brief presentations of general principles, then throw out multiple-choice questions that students "vote" on, using wireless "personal response clickers." These devices transmit the answers to a computer monitored by the professor, helping her gauge the level of understanding in the room. "You know where they are," she says. She can then adjust, slow down, or engage students in guided discussions of their answers.[6] An Indiana University sociology instructor uses similar technology to get students to answer questions about themselves—race, income, political affiliation—showing how, for example, the class is skewed toward wealthier or poorer students, an event that can stir up a half hour of excited class discussion.[7]

Maybe the classrooms at your school haven't reached this level of interactivity yet, but there's no question that information technology is universal on college campuses, and at lower levels the internet has penetrated 99% of schools.[8] Most college students have been exposed to computers since the lower grades. In fact, one-fifth of college students report they were using computers between the ages 5 and 8, and all had begun using computers by the time they were 16–18 years old.

When properly integrated into the curriculum and classroom, information technology can (1) allow students to personalize their education; (2) automate many tedious and rote tasks of teaching and managing classes; and (3) reduce the teacher's workload per student, so that he or she can spend more time on reaching individual students.[9] For instance, ***email*, or "electronic mail," messages transmitted over a computer network, most often the internet,** are used by students to set up appointments (62%) with professors, discuss grades (58%), or get clarification of an assignment (75%).[10]

Besides using the internet to help in teaching, today's college instructors also use *presentation graphics software* such as PowerPoint to show their lecture outlines and other materials on classroom screens (as we discuss in Chapter 3). In addition, they use Blackboard,

more info!

Online Colleges

The following websites provide detailed information about getting college degrees online:

www.classesusa.com/indexall/?campusType=online
www.guidetoonlineschools.com
www.usdla.org
http://distancelearn.about.com/
http://www.distancelearning.com/

A 6-year-old girl plays a Sesame Street interactive program at Maxwell Memorial Library in Camilluis, New York.

WebCT, and other ***course-management software*** **for administering online assignments, schedules, examinations, and grades.**[11] One of the most intriguing developments in education at all levels, however, is the rise of ***distance learning*****, or *e-learning*, the name given to online education programs,** which has gone from under 2 million online students in 2003 to an expected nearly 5 million students in 2009.[12] E-learning has had some interesting effects. For example, the availability of the internet has helped to propel the home-schooling movement, in which children are taught at home, usually by parents, to expand from 1.7% of all school-age children in 1999 to 2.9% in 2007.[13] E-learning has also propelled the rise of for-profit institutions, such as DeVry and the University of Phoenix, which 8% of full-time college students now attend.[14] More than a third of institutions of higher education—and 97% of public universities—offer online courses, and many have attracted on-campus students, who say they like the flexibility of not having to attend their classes at a set time.[15]

Avatar. The simulated depictions of humans are a staple not only of videogames but also of computerized training programs. (What culture does "avatar" come from? See *www. answers.com/topic/avatar?cat=technology.)*

E-learning has been put to such varied uses as bringing career and technical courses to high school students in remote prairie towns, pairing gifted science students with master teachers in other parts of the country, and helping busy professionals obtain further credentials outside business hours. But the reach of information technology into education has only begun. In the future, we will see software called "intelligent tutoring systems" that gives students individualized instruction when personal attention is scarce—such as the software Cognitive Tutor, which not only helps high school students to improve their performance in math but also sparks them to enjoy a subject they might have once hated. In colleges, more students may use interactive simulation games, such as McGraw-Hill's Business Strategy Game, to apply their knowledge to real-world kinds of problems. And employees in company training programs may find themselves engaged in mock conversations with ***avatars*****—computer depictions of humans,** as are often found in online videogames—that represent imaginary customers and coworkers, combining the best parts of computer-based learning with face-to-face interaction.[16]

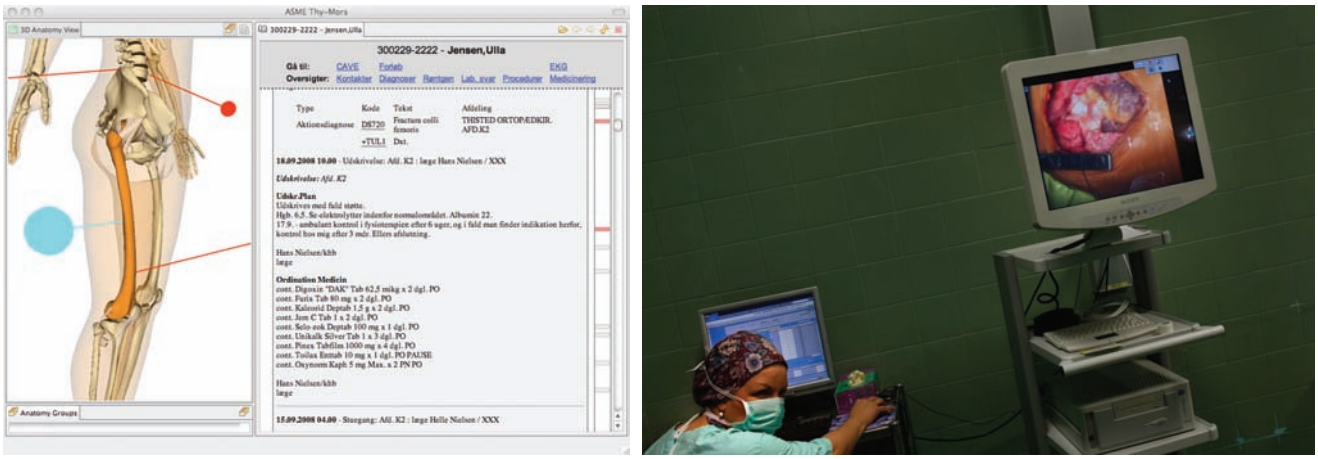
Health: High Tech for Wellness

How are computers being used in health and medicine?

Neurologist Bart Demaerschalk of Phoenix, Arizona, was at home tucking into his Thanksgiving dessert when he received a message that a woman 200 miles away had developed drooping facial muscles and slurred speech. Within a few minutes, Demaerschalk was looking at her, asking questions, reviewing her brain scan, and confirming a diagnosis of stroke—all with the help of a two-way video and audio connection set up for just this kind of consultation.[17]

Damaerschalk's story is an example of ***telemedicine*****—medical care delivered via telecommunications.** For some time, physicians in rural areas lacking local access to radiologists have used "teleradiology" to exchange computerized images such as X rays via telephone-linked networks with expert physicians in metropolitan areas. Now telemedicine is moving to an exciting new level, as the use of digital cameras and sound, in effect, moves patients to doctors rather than the reverse. Already telemedicine is being embraced by administrators in the American prison system, where by law inmates are guaranteed medical treatment—and where the increase in prisoners every year has led to the need to control health care costs.

Computer technology is radically changing the tools of medicine. All medical information, including that generated by X ray, lab test, and pulse monitor,



High-tech medicine. (*left*) Screenshot of the visual patient record software pioneered at Thy-Mors hospital. This patient has had a fracture of the femur in the right leg. This computer-based image shows a close-up view of the treated area. A click on the arrow or the highlighted femur would show the pertinent medical information from the record on the right panel. The tool allows doctors to easily zoom in an out on a particular body region or part and choose between many different views, for example, the cardiovascular system, the central nervous system, or the muscular system. (*right*) Open heart surgery is seen on a computer monitor as an Israeli medical team repairs a congenital defect in a boy's heart at the Wolfson Medical Center in Tel Aviv.

can now be transmitted to a doctor in digital format. Image transfer technology allows radiologic images such as CT scans and MRIs to be immediately transmitted to electronic charts and physicians' offices. Patients in intensive care, who are usually monitored by nurses during off-times, can also be watched over by doctors in remote "control towers" miles away. Electronic medical records and other computerized tools enable heart attack patients to get follow-up drug treatment and diabetics to have their blood sugar measured. Software can compute a woman's breast cancer risk.[18] Patients can use email to query their doctors about their records (although there are still privacy and security issues).[19]

Various ***robots*—automatic devices that perform functions ordinarily performed by human beings,** with names such as ROBO DOC, RoboCart, TUG, and HelpMate—help free medical workers for more critical tasks; the four-armed da Vinci surgical robot, for instance, can do cuts and stitches deep inside the body, so that surgery is less traumatic and recovery time faster.[20] Hydraulics and computers are being used to help artificial limbs get "smarter."[21] And a patient paralyzed by a stroke has received an implant that allows communication between his brain and a computer; as a result, he can move a cursor across a screen by brainpower and convey simple messages—as in *Star Trek*.[22]

Want to calculate how long you will live? Go to *www.livingto100.com*, an online calculator developed by longevity researchers at Harvard Medical School and Boston Medical Center. Want to gather your family health history to see if you're at risk for particular inherited diseases? Go to *www.hhs.gov/familyhistory* to find out how. These are only two examples of health websites available to patients and health consumers. Although online health information can be misleading and even dangerous (for example, be careful about relying on Wikipedia for health advice), many people now tap into health care databases, email health professionals, or communicate with people who have similar conditions.

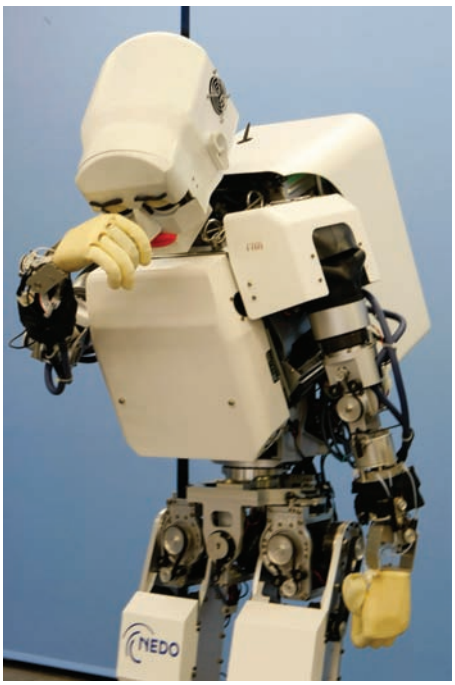
Often patients are already steeped in information about their conditions when they arrive in the offices of health care professionals. This represents a fundamental shift of knowledge, and therefore power, from physicians to patients. In addition, health care consumers are able to share experiences and information with one another. Young parents, for example, can find an online gathering spot (chat room) at pediatrician Alan Greene's website at *www.drgreene.com*. If you want to put your medical records on an electronic keychain storage device, visit *med-infochip.com*.

more info!

Health Websites

Some reliable sources:

www.medlineplus.gov
www.nimh.nih.gov
www.4woman.gov
www.mayoclinic.com
www.nationalhealthcouncil.org
www.yourdiseaserisk.wustl.edu/



Robots. (*left*) A humanoid robot, HRP-2 Promet, developed by the National Institute of Advanced Industrial Science and Technology and Kawada Industries, Inc. Five feet tall, it performs traditional Japanese dancing. Priced at $365,000, the robot can help workers at construction sites and also drive a car. (*middle*) This sea bream is about 5½ pounds and can swim up to 38 minutes before recharging. The robot fish, created by Mitsubishi, looks and swims exactly like the real thing. (*right*) Humanoid robot KOBIAN displays an emotion of sadness during a demonstration at Waseda University in Tokyo, Japan. KOBIAN, which can express seven programmed emotions by using its entire body, including facial expressions, has been developed by researchers at Waseda's Graduate School of Advanced Science and Engineering.

Money: Toward the Cashless Society

How will computers affect my financial matters?

"The future of money is increasingly digital, likely virtual, and possibly universal," says one writer.[23] ***Virtual*** **means that something is created, simulated, or carried on by means of a computer or a computer network,** and we certainly have come a long way toward becoming a cashless society. Indeed, the percentage of all financial transactions done electronically, both phone-initiated and computer-initiated, was projected to rise to 18.4% in 2013, up from 0.9% in 1993.[24] Besides currency, paper checks, and credit and debit cards, the things that serve as "money" include cash-value cards (such as subway fare cards), automatic transfers (such as direct-deposit paychecks), and digital money ("electronic wallet" accounts such as PayPal).

Many readers of this book will probably already have engaged in online buying and selling, purchasing DVDs, books, airline tickets, or computers. But what about groceries? After all, you can't exactly squeeze the cantaloupes through your keyboard. Even so, online groceries are expected to reach $7.5 billion in U.S. sales by 2012.[25] To change decades of shopping habits, e-grocers keep their delivery charges low and delivery times convenient, and they take great pains in filling orders, knowing that a single bad piece of fruit will produce a devastating word-of-mouth backlash.

more info!

Financial Information

The internet contains lots of financial information. Some of the better sources:

www.finance.yahoo.com

www.fool.com

www.ragingbull.com

www.usatoday.com/money/default.htm

Only about 46% of U.S. workers have their paychecks electronically deposited into their bank accounts (as opposed to 95% or more in Japan, Norway, and Germany, for example), but this is sure to change as Americans discover that direct deposit is actually safer and faster. Online bill paying is also picking up steam. For more than two decades, it has been possible to pay bills online, such as those from phone and utility companies, with special software and online connections to your bank.

Some banks and other businesses are backing an electronic-payment system that allows internet users to buy goods and services with ***micropayments*, electronic payments of as little as 25 cents in transactions for which it is uneconomical to use a credit card.** The success of Apple Computer's iTunes online music service, which sells songs for 99 cents each, suggests that micro sales are now feasible. All kinds of businesses and organizations, from independent songwriters to comic book writers to the Legal Aid Society of Cleveland, now accept micropayments, using intermediaries such as BitPass and Peppercoin.[26] Thus, you could set up your own small business simply by constructing a website (we show you how later in the book) and accepting micropayments.

Leisure: Infotech in Entertainment & the Arts

How will my leisure activities be affected by information technology?

Information technology is being used for all kinds of entertainment, ranging from videogames to telegambling. It is also being used in the arts, from painting to photography. Let's consider just two examples, music and film.

Computers, the internet, and the World Wide Web are standing the system of music recording and distribution on its head—and in the process are changing the financial underpinnings of the music industry. Because of their high overhead, major record labels typically need a band to sell half a million CDs in order to be profitable, but independent bands, using online marketing, can be reasonably successful selling 20,000 or 30,000 albums. Team Love, a small music label established in 2003, found it could promote its first two bands, Tilly and the Wall and Willy Mason, by offering songs online free for ***downloading*—transferring data from a remote computer to one's own computer**—so that people could listen to them before paying $12 for a CD. It also puts videos online for sharing and uses quirky websites to reach fans. "There's something exponential going on," says one of Team Love's founders. "The more music that's downloaded, the more it sells."[27] Many independent musicians are also using the internet to get their music heard, hoping that giving away songs will help them build audiences.[28]

Download (reverse the direction of data transmission to **upload**)

Download
(reverse the direction of data transmission to **upload**)

The web also offers sources for instantly downloadable sheet music (see *www.everynote.com, www.musicnotes.com, www.sheetmusicdirect.com,* and *www.sunhawk.com*). One research engineer has devised a computerized scoring system for judging musical competitions that overcomes the traditional human-jury approach, which can be swayed by personalities and politics.[29] And a Spanish company, Polyphonic HMI, has created Hit Song Science software, which they say can analyze the hit potential of new songs by, according to one description, "reference to a finely parsed universe of attributes derived from millions of past songs."[30]

As for movies, now that blockbuster movies routinely meld live action and animation, computer artists are in big demand. The 1999 film *Star Wars: Episode I,* for instance, had 1,965 digital shots out of about 2,200 shots. Even when film was used, it was scanned into computers to be tweaked with animated effects, lighting, and the like. Entire beings were created on computers by artists working on designs developed by producer George Lucas and his chief artist.[31]

What is driving the demand for computer artists? One factor is that animation, though not cheap, looks more and more like a bargain, because hiring movie actors costs so much—some make $20 million a film. Moreover, special

more info!

Free Music Online

Places to look for free—and legal—music online:

new.music.yahoo.com
www.epitonic.com
http://memory.loc.gov/ammem/audio.html
www.archive.org
www.garageband.com

Entertainment. (*left*) Computer-generated special effects shot from the movie *Up.* (*right*) An indoor "winter" sports facility in Japan; the system uses microprocessors to keep lifts running, snow falling, and temperature at 26 degrees.

more info!

Online Movie Tickets

Three sites offer movie tickets, as well as reviews and other materials. In some cities you can print out tickets at home.

www.fandango.com
www.moviefone.com
www.movietickets.com

effects are readily understood by audiences in other countries, and major studios increasingly count on revenues from foreign markets to make a film profitable. Digital manipulation also allows a crowd of extras to be multiplied into an army of thousands. It can also be used to create settings: in the film *Sky Captain and the World of Tomorrow,* the actors—Gwyneth Paltrow, Angelina Jolie, and Jude Law—shot all their scenes in front of a blue screen, and computer-generated imagery was then used to transport them into an imaginary world of 1939.[32] Computer techniques have even been used to develop digitally created actors—called "synthespians." (Thespis was the founder of ancient Greek drama; thus, a thespian works in drama as an actor.) Actors ranging from the late James Dean to the late John Wayne, for instance, have been recruited for television commercials. And computerized animation is now so popular that Hollywood studios and movie directors are finding they can make as much money from creating videogames as from making movies.[33]

But animation is not the only area in which computers are revolutionizing movies. Digital editing has radically transformed the way films are assembled. Whereas traditional film editing involved reeling and unreeling spools of film and cutting and gluing pieces of highly scratchable celluloid together, nearly burying the editor in film, today an editor can access 150 miles of film stored on a computer and instantly find any visual or audio moment, allowing hundreds of variations of a scene to be called up for review. Even nonprofessionals can get into movie making as new computer-related products come to market. Now that digital video capture-and-edit systems are available for under $1,000, amateurs can turn home videos into digital data and edit them. Also, digital camcorders, which offer outstanding picture and sound quality, have steadily dropped in price.

Government & Electronic Democracy: Participating in the Civic Realm

In what ways are computers changing government and politics?

The internet and other information technology have helped government deliver better services and have paved the way for making governmental operations more transparent to the public. For instance, during a health crisis involving salmonella-tainted peanut butter, the U.S. Food and Drug Administration sent out information 707 times per minute in response to citizens seeking information about it.[34] The U.S. State Department has a "DipNote" blog read by 2 million readers, and it holds press conferences on YouTube.[35] Congress has a publicly searchable website for all federal contracts and grants over $25,000,

Electronic voting. Voting using computer technology and a touch screen to vote.

and a growing number of states are putting everything from budgets to contracts to travel expenses online for the public to look at.[36] The White House also has its own website (www.whitehouse.gov) with its Open Government Dialogue blog.[37] Many local and state governments also have websites through which citizens can deal with everything from paying taxes and parking tickets, to renewing vehicle registration and driver's licenses, viewing birth and marriage certificates, and applying for public sector jobs.

The internet is also changing the nature of politics, enabling political candidates and political interest groups to connect with voters in new ways, to raise money from multiple small donors instead of just rich fat cats, and (using cellphones and text messaging) to organize street protests.[38] The Barack Obama campaign was said to be particularly adept at exploiting information technology during his run for the presidency in 2008 and afterward for staying in touch with supporters to help him govern.[39] Yet information also has its downside, as computers have allowed incumbent legislators to design (gerrymander) voting districts that make it nearly impossible for them to be dislodged; electronic tools have also made it easier than ever for political parties to skirt or break campaign laws, and computerized voting machines still don't always count votes as they are supposed to. Still, websites and bloggers have become important watchdogs on government. The website E-Democracy (*www.e-democracy.org*), for instance, can help citizens dig up government conflicts of interest, and websites such as Project Vote Smart (*www.votesmart.org*) outline candidates' positions.

more info!

Online Government Help

You can gain access to government agencies through the following websites:

www.firstgov.gov
www.govspot.com
www.info.gov

Jobs & Careers

How could I use computers to advance my career?

Today almost every job and profession requires computer skills of some sort. Some are ordinary jobs in which computers are used as ordinary tools. Others are specialized jobs in which advanced computer training combined with professional training gives people dramatically new kinds of careers.

Consider:

- In the hotel business, even front-desk clerks need to know how to deal with computerized reservation systems. Some hotels, however, also have a so-called computer concierge, someone with knowledge of computer systems who can help computer-carrying guests with online and other tech problems.
- In law enforcement, police officers need to know how to use computers while on patrol or at their desks to check out stolen cars, criminal

Careers. Front-desk workers at many hotels use computers to check guests in.

Police work. Syracuse, New York: An Onondaga County sheriff's deputy enters information into a laptop in his squad car as he issues a ticket for an uninspected vehicle. The officer was using the sheriff's department's new computer database system.

records, outstanding arrest warrants, and the like. However, investigators with specialized computer backgrounds are also required to help solve fraud, computer break-ins, accounting illegalities, and other high-tech crimes.

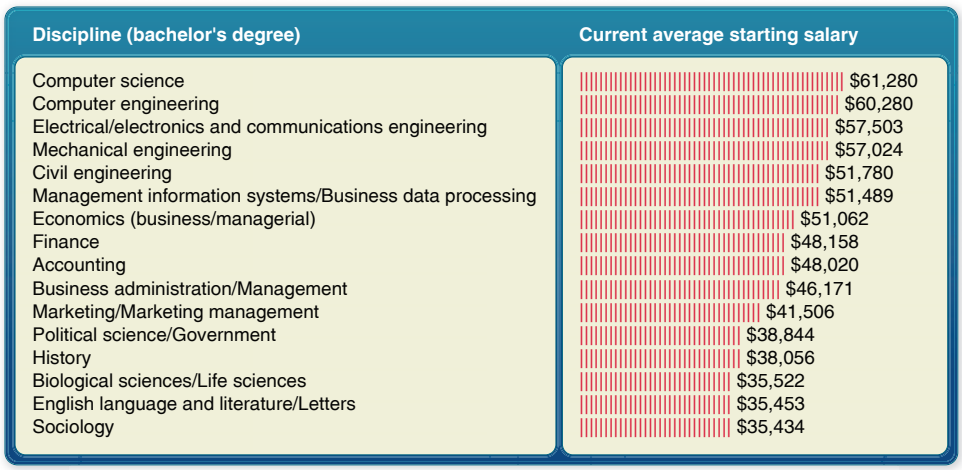
- In entertainment, computers are used for such ordinary purposes as budgets, payroll, and ticketing. However, there are also new careers in virtual set design, combining training in architecture and 3-D computer modeling, and in creating cinematic special effects.

Clearly, information technology is changing old jobs and inventing new ones. To prosper in this environment, you need to combine a traditional education with training in computers and communications. You also need to be savvy about job searching, résumé writing, interviewing, and postings of employment opportunities. Advice about careers, job hunting, occupational trends, and employment laws is available at Yahoo!, Google, and other websites. Some starting annual salaries for recent college graduates are shown below; note that jobs involving degrees in computers and information systems occupy four of the seven top-paying starting salaries *(● See Panel 1.2.)*

Computers can be used both for you to find employers and for employers to find you.[40]

WAYS FOR YOU TO FIND EMPLOYERS As you might expect, the first to use cyberspace as a job bazaar were companies seeking people with technical backgrounds and technical people seeking employment. However, as the public's interest in commercial services and the internet has exploded, the focus of online job exchanges has broadened. Now, interspersed among ads for programmers on the internet are openings for forest rangers in Idaho, physical therapists in Atlanta, models in Florida, and English teachers in China. Most websites are free to job seekers, although many require that you fill out an online registration form. *(● See Panel 1.3.)*

WAYS FOR EMPLOYERS TO FIND YOU Posting your résumé online for prospective employers to view is attractive because of its low (or zero) cost and wide reach. But does it have any disadvantages? Certainly it might if the employer who sees your posting happens to be the one you're already working for. In addition, you have to be aware that you lose control over anything broadcast



panel 1.2

Entering the job market
Average starting salary offers for 2008 college graduates

Source: Adapted from the *NACE Average Starting Salary Offer Survey Results (2008),* Purdue University Calumet, posted February 27, 2009, http://209.85.173.132/search?q=cache:http://webs calumet.purdue.edu/careerservices/files/2008/10/nace-salary-survey.pdf (accessed April 21, 2009). The original survey is by the National Association of Colleges and Employers, copyright holder. © National Association of Colleges and Employers. All rights reserved. 62 Highland Ave., Bethlehem, PA 18017, www.nacewb.org.

panel 1.3

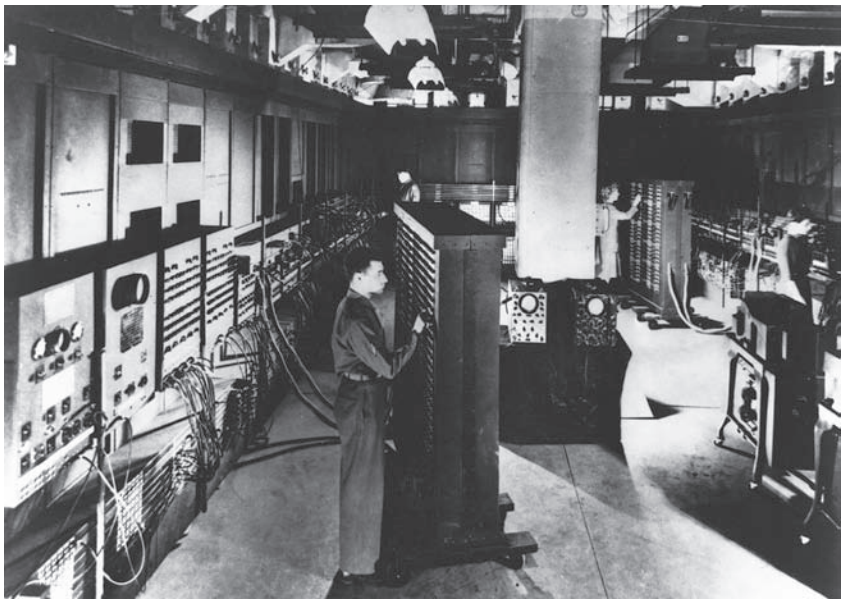
Some websites that post job listings

Career One Stop: *www.jobbankinfo.org*
Career Builder: *www.careerbuilder.com*
College Grad Job Hunter: *www.collegegrad.com*
Erecruiting: *www.erecruiting.com*
FedWorld (U.S. Government jobs): *www.fedworld.gov*
NationJob Network: *www.nationjob.com*
Indeed.com: *www.indeed.com*
Yahoo! Hot Jobs: *http://hotjobs.yahoo.com*
Jobs.com: *www.jobs.com*
Jobs on Line: *www.jobsonline.com*
MonsterTrak.com: *www.jobtrak.com*
JobWeb: *www.jobweb.org*
Monster.com: *www.monster.com*
Simply Hired: *www.simplyhired.com*

into cyberspace. You're putting your credentials out there for the whole world to see, and you need to be somewhat concerned about who might gain access to them.

If you have a technical background, it's definitely worth posting your résumé with an electronic jobs registry, since technology companies in particular find this an efficient way of screening and hiring. However, posting may also benefit people with less technical backgrounds. Online recruitment is popular with companies because it prescreens applicants for at least basic computer skills. If you've mastered the internet, you're likely to know something about word processing, spreadsheets, and database searching as well, knowledge required in most good jobs these days.

One wrinkle in job seeking is to prepare a résumé with web links and/or clever graphics and multimedia effects and then put it on a website to entice employers to chase after you. If you don't know how to do this, there are many companies that—for a fee—can convert your résumé and publish it on their own websites. Some of these services can't dress it up with fancy graphics or multimedia, but since complex pages take longer for employers to download anyway, the extra pizzazz is probably not worth the effort. A number of websites allow you to post your résumé for free. Another wrinkle is to pay extra to move your résumé higher in the listings so that it will stand out compared with competing résumés. For example, for an extra $20–$150 apiece, Careerbuilder.com will move your listing toward the top of the search heap, and the company says that employers click on upgraded résumés 200% more often than on regular ones.[41]



panel 1.4

Grandparent and offspring
ENIAC (*left*) is the grandparent of today's smartphones (*right*).

I.3 INFOTECH IS ALL-PERVASIVE: Cellphones, Email, the Internet, & the E-World

***How does information technology facilitate email, networks, and the use of the internet and the web; what is the meaning of the term* cyberspace?**

One of the first computers, the outcome of military-related research, was delivered to the U.S. Army in 1946. ENIAC (short for "Electronic Numerical Integrator And Calculator") weighed 30 tons and was 80 feet long and two stories high, but it could multiply a pair of numbers in the then-remarkable time of three-thousandths of a second. *(● See Panel 1.4.)* This was the first general-purpose, programmable electronic computer, the grandparent of today's lightweight handheld machines—including the smart cellphone. Some of the principal historical developments are illustrated in the timeline below. *(● See Panel 1.5.)*

panel 1.5

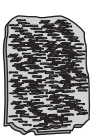
Timeline
Overview of some of the historical developments in information technology. The timeline is modified in upcoming chapters to show you more about the people and advances contributing to developments in information technology.

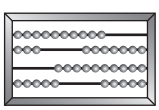
The Phone Grows Up

How has the telephone changed?

Cellphone e-mania has swept the world. All across the globe, people have acquired the portable gift of gab, with some users making 45 or more calls a day. Strategy Analytics has estimated that worldwide mobile phone subscriptions will rise to 3.9 billion in 2013; more than half the world's population will be using mobile phones by 2010.[42] It has taken more than 100 years for the

4000–1200 BCE	3500 BCE–2900 BCE	3000 BCE	1270 BCE	900 BCE	530 BCE	100 CE
Inhabitants of the first known civilization in Sumer keep records of commericial transactions on clay tablets	Phoenicians develop an alphabet; Sumerians develop cuneiform writing; Egyptians develop hierogylphic writing	Abacus is invented in Babylonia	First encyclopedia (Syria)	First postal service (China)	Greeks start the first library	First bound books





Smartphones. (*left*) Motorola Q9c smartphone. (*middle*) Ojo videophone, which allows face-to-face chats long distance. (*right*) Bandai Networks' mobile phone that displays a novel. Bandai offers 150 books on its site for phone owners to download and read on their phones.

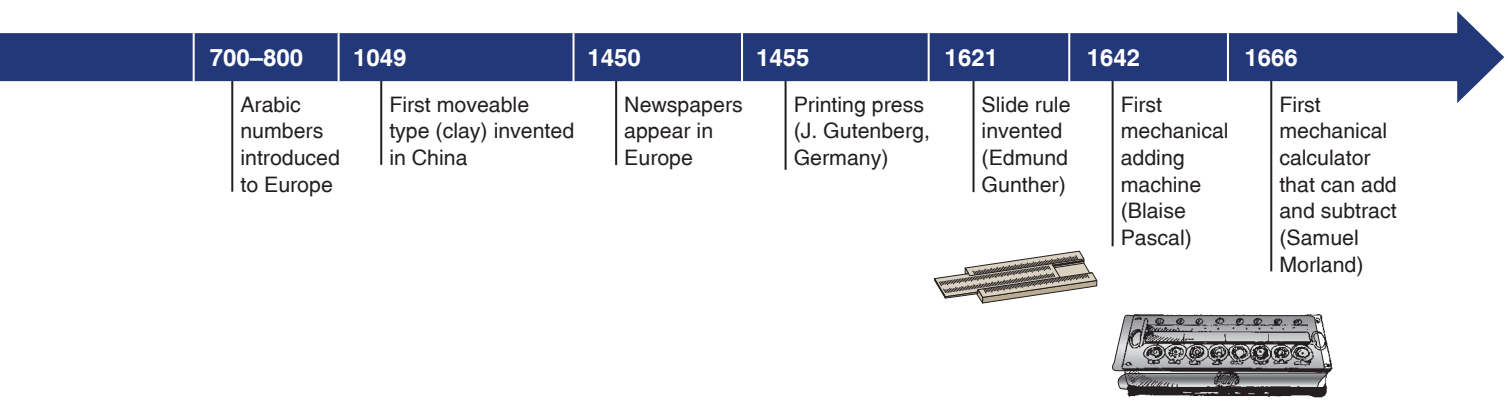
telephone to get to this point—getting smaller, acquiring push buttons, losing its cord connection. In 1964, the * and # keys were added to the keypad. In 1973, the first cellphone call was processed.

In its most basic form, the telephone is still so simply designed that even a young child can use it. However, it is now becoming more versatile and complex—a way of connecting to the internet and the World Wide Web. Indeed, internet smartphones—such as the Apple iPhone, the Samsung Instinct, the palm Centro, and the Motorola Q9c—represent another giant step for information technology. Now you no longer need a personal computer to get on the internet. Smartphones in their various forms enable you not only to make voice calls but also to send and receive text messages, browse the World Wide Web, and obtain news, research, music, photos, movies, and TV programs. (And with camera and camcorder cellphones, you can send images, too.)[43] According to one survey, the percentage of people who use nonvoice applications for text messages is 27%; email 11%; internet 9%; and photography 6%—and the numbers of users for these options are growing all the time.[44]

"You've Got Mail!" Email's Mass Impact

What makes email distinctive from earlier technologies?

It took the telephone 40 years to reach 10 million customers, and fax machines 20 years. Personal computers made it into that many American homes 5 years



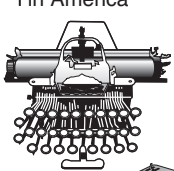
after they were introduced. Email, which appeared in 1981, became popular far more quickly, reaching 10 million users in little more than a year.[45] No technology has ever become so universal so fast. Thus, one of the first things new computer and internet users generally learn is how to send and receive email.

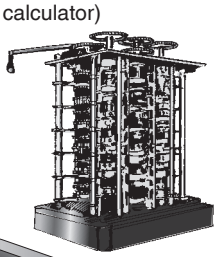
Until 1998, hand-delivered mail was still the main means of correspondence. But in that year, the volume of email in the United States surpassed the volume of hand-delivered mail. In 2007, the total number of email messages sent daily has been estimated at 183 billion worldwide.[46] Already, in fact, email is the leading use of PCs. Because of this explosion in usage, suggests a *BusinessWeek* report, "email ranks with such pivotal advances as the printing press, the telephone, and television in mass impact."[47]

Using electronic mail clearly is different from calling on a telephone or writing a conventional letter. As one writer puts it, email "occupies a psychological space all its own. It's almost as immediate as a phone call, but if you need to, you can think about what you're going to say for days and reply when it's convenient."[48] Email has blossomed, points out another writer, not because it gives us more immediacy but because it gives us *less*. "The new appeal of email is the old appeal of print," he says. "It isn't instant; it isn't immediate; it isn't in your face." Email has succeeded for the same reason that the videophone—which allows callers to see each other while talking—has been so slow to catch on: because "what we actually want from our exchanges is the minimum human contact commensurate with the need to connect with other people."[49] It will be interesting to see, however, whether this observation holds up during the next few years if marketers roll out more videophones.

What is interesting, though, is that in these times when images often seem to overwhelm words, email is actually *reactionary*. "The internet is the first new medium to move decisively backward," points out one writer, because it essentially involves writing. Twenty years ago, "even the most literate of us wrote maybe a half a dozen letters a year; the rest of our lives took place on the telephone."[51] Email has changed all that—and has put pressure on businesspeople in particular to sharpen their writing skills. (A countertrend, unfortunately, is that the informal style of electronic messages is showing up in schoolwork.)[52]

1714	1801	1820	1829	1833	1843
First patent for a typewriter (England)	A linked sequence of punched cards controls the weaving patterns in Jacquard's loom	The first mass-produced calculator, the Thomas Arithnometer	William Austin patents the first workable typewriter in America	Babbage's difference engine (automatic calculator)	World's first computer programmer, Ada Lovelace, publishes her notes





PRACTICAL ACTION

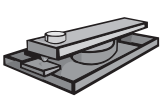
Managing Your Email

For many people, email *is* the online environment, more so than the World Wide Web. According to one study, 60% of people who do emailing at work average 10 or fewer messages a day, 23% receive more than 20, and 6% receive more than 50.[50] But some people receive as many as 300 emails a day—with perhaps 200 being junk email (spam), bad jokes, or irrelevant memos (the "cc," previously "carbon copy," now "courtesy copy").

It's clear, then, that email will increase productivity only if it is used properly. Overuse or misuse just causes more problems and wastes time. The following are some ideas to keep in mind when using email:

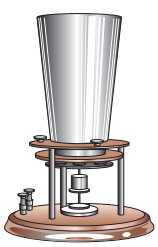
- *Do your part to curb the email deluge:* Put short messages in the subject line so that recipients don't have to open the email to read the note. Don't reply to every email message you get. Avoid "cc:ing" (copying to) people unless absolutely necessary. Don't send chain letters or lists of jokes, which just clog mail systems.
- *Be helpful in sending attachments:* Attachments—computer files of long documents or images attached to an email—are supposed to be a convenience, but often they can be an annoyance. Sending a 1-megabyte file to a 500-person mailing list creates 500 copies of that file—and that many megabytes can clog the mail system. (A 1-megabyte file is about the size of a 300-page double-spaced term paper.) Ask your recipients beforehand if they want the attachment.
- *Be careful about opening attachments you don't recognize:* Some dangerous computer viruses—renegade programs that can damage your computer—have been spread by email attachments that automatically activate the virus when they are opened.
- *Use discretion about the emails you send:* Email should not be treated as informally as a phone call. Don't send a message electronically that you don't want some third party to read. Email messages are not written with disappearing ink; they remain in a computer system long after they have been sent. Worse, recipients can easily copy and even alter your messages and forward them to others without your knowledge.
- *Make sure emails to bosses, coworkers, and customers are literate:* It's okay to be informal when emailing friends, but employers and customers expect a higher standard. Pay attention to spelling and grammar.
- *Don't use email to express criticism and sarcasm:* Because email carries no tone or inflection, it's hard to convey emotional nuances. Avoid criticism and sarcasm in electronic messaging. Nevertheless, you can use email to provide quick praise, even though doing it in person will take on greater significance.
- *Be aware that email you receive at work is the property of your employer:* Be careful of what you save, send, and back up.
- *Realize that deleting email messages doesn't totally get rid of them:* "Delete" moves the email from the visible list, but the messages remain on your hard disk and can be retrieved by experts. Special software, such as Spytech Eradicator and Window Washer, will completely erase email from the hard disk.
- *Don't neglect real personal contact:* More companies are asking employees to trade email for more in-person contact with the people they work with, through such practices as banning the use of email on Fridays. This has come about because so many employees complain that they have to leave multiple messages when trying to get answers since coworkers don't respond in timely fashion.

1844 Samuel Morse sends a telegraph message from Washington to Baltimore

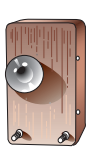


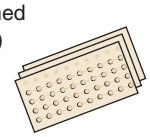
1854 George Boole publishes "An Investigation on the Laws of Thought," a system for symbolic and logical reasoning that will become the basis for computer design

1876 Alexander Graham Bell patents the telephone



1890 Electricity used for first time in a data-processing project—Hollerith's automatic census-tabulating machine (used punched cards)





1895 First radio signal transmitted

1907 First regular radio broadcasts, from New York

1920–1921 The word "robot," derived from the Czech word for compulsory labor, is first used to mean a humanlike machine

The Internet, the World Wide Web, & the "Plumbing of Cyberspace"

What's the difference between the net, the web, and cyberspace?

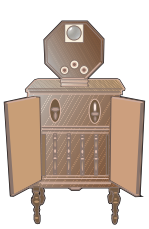
As the success of the cellphone shows, communications has extended into every nook and cranny of civilization (with poorer nations actually the leaders in cellphone growth), a development called the "plumbing of cyberspace." The term *cyberspace* was coined by William Gibson in his novel *Neuromancer* (1984) to describe a futuristic computer network into which users plug their brains. (*Cyber* comes from "cybernetics," a term coined in 1948 to apply to the comparative study of automatic control systems, such as the brain/nervous system and mechanical-electrical communication systems.) In everyday use, this term has a rather different meaning.

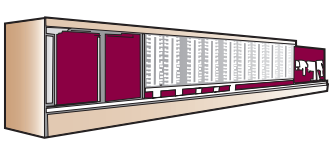
Today many people equate cyberspace with the internet. But it is much more than that. Cyberspace includes not only the web, chat rooms, online diaries (blogs), and member-based services such as America Online—all features we explain in this book—"but also such things as conference calls and automatic teller machines," says David Whittler.[53] We may say, then, that ***cyberspace*** **encompasses not only the online world and the internet in particular but also the whole wired and wireless world of communications in general**—the nonphysical terrain created by computer and communications systems. Cyberspace is where you go when you go online with your computer.

THE NET & WEB DEFINED The two most important aspects of cyberspace are the internet and that part of the internet known as the World Wide Web. To give them formal definition:

- **The internet—"the mother of all networks":** The internet is at the heart of the Information Age. Called "the mother of all networks," the ***internet*** **(the "net") is a worldwide computer network that connects hundreds of thousands of smaller networks. These networks link educational, commercial, nonprofit, and military entities, as well as individuals.**
- **The World Wide Web—the multimedia part of the internet:** The internet has been around for more than 40 years. But what made it popular, apart from email, was the development in the early 1990s of the ***World Wide Web*****, often called simply the "Web" or the "web"—an interconnected system of internet computers (called *servers*) that support specially formatted documents in multimedia form.** The word *multimedia,* from "multiple media," refers to technology that presents information in more than one medium, such as text, still images, moving images, and sound. In other words, the web provides information in more than one way.

1924	1927	1941	1942	1944	1945
T.J. Watson renames Hollerith's machine company, founded in 1896, to International Business Machines (IBM)	First demonstration of television in USA	Konrad Zuse (Germany) produces the first fully functional programmable digital computer, the Z3 (ran by perforated celluloid strips)	First electronic digital computer (but non-programmable) developed by John Atanasoff and Clifford Berry	First programmable electromechanical computer (Mark I) (owned by the U.S. government)	John von Neumann introduces the concept of a stored program





Always on Most of today's students don't remember a time before the existence of cyberspace.

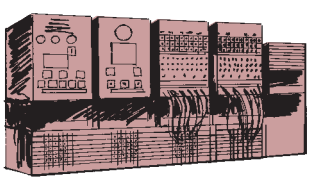
THE INTERNET'S INFLUENCE There is no doubt that the influence of the net and the web is tremendous. At present, 75% of American adults use the internet, according to the Pew Internet & American Life Project.[54] Seventy-two percent of American adult internet users use the net on an average day, with 60% using it to send or read email.[55] But just how revolutionary is the internet? Is it equivalent to the invention of television, as some technologists say? Or is it even more important—equivalent to the invention of the printing press? "Television turned out to be a powerful force that changed a lot about society," says *USA Today* technology reporter Kevin Maney. "But the printing press changed everything—religion, government, science, global distribution of wealth, and much more. If the internet equals the printing press, no amount of hype could possibly overdo it."[56]

College Students & the E-World

How does my use of information technology compare with that of other students?

One thing we know already is that cyberspace is saturating our lives. The worldwide internet population was 1.59 billion (or nearly 24% of the world's population in 2009). About 251 million of those internet users were in North America, representing a penetration of 74% of the population.[57] While the average age of users is

1946 First programmable electronic computer in United States (ENIAC)



1947 Invention of the transistor (enabled miniaturization of electronic devices)

1951 Computers are first sold commercially

1952 UNIVAC computer correctly predicts election of Eisenhower as U.S. President

1958 Integrated circuit; first modem

1962 The first computer game is invented (Spacewar)

1969 ARPANet established by U.S. Advanced Research Projects Agency; led to internet

rising, there's no doubt that people ages 18–29 love the internet, with 87% of them using it; among all computer users with a college education, 95% use the net.[58]

Teens and young adults (age 18–32) are the most likely of all groups to use the internet for communicating with friends and family; for entertainment—especially online videos, online games, and virtual worlds (such as for multiplayer online role-playing games)—and for obtaining music. They are also considerably more likely than older users to use social networking sites—online communities, such as Facebook and Twitter, that allow members to keep track of their friends and share photos, videos, and the like. In addition, young people are more apt to send instant messages and to do text messaging (texting) with friends—send brief written messages between cellphones.[59] We consider all these technologies later in the book.

I.4 THE "ALL-PURPOSE MACHINE": The Varieties of Computers

What are the five sizes of computers, and what are clients and servers?

When the ★alarm clock blasts you awake, you leap out of bed and head for the kitchen, where you check the ★coffee maker. After using your ★electronic toothbrush and showering and dressing, you stick a bagel in the ★microwave, and then pick up the ★TV remote and click on the ★TV to catch the weather forecast. Later, after putting dishes in the ★dishwasher, you go out and start up the ★car and head toward campus or work. Pausing en route at a ★traffic light, you turn on your ★iPod to listen to some music. And you might use your ★GPS system to get to your destination.

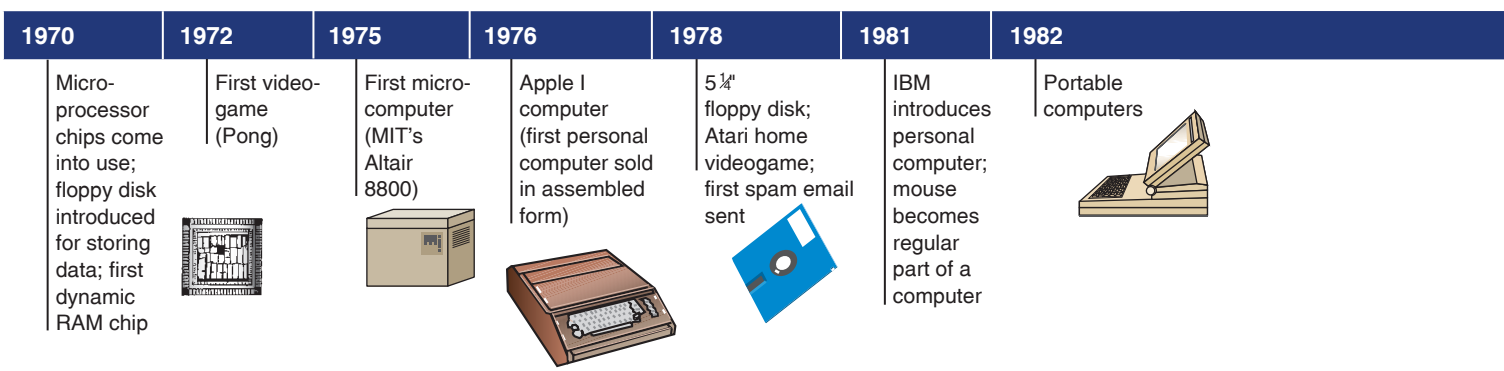
You haven't yet touched a PC, a personal computer, but you've already dealt with at least 11 computers—as you probably guessed from the ★s. All these familiar appliances rely on tiny "computers on chips" called *microprocessors*. Maybe, then, the name "computer" is inadequate. As computer pioneer John von Neumann has said, the device should not be called the computer but rather the "all-purpose machine." It is not, after all, just a machine for doing calculations. The most striking thing about it is that it can be put to *any number of uses*.

What are the various types of computers? Let's take a look.

All Computers, Great & Small: The Categories of Machines

What are the five sizes of computers?

At one time, the idea of having your own computer was almost like having your own personal nuclear reactor. In those days, in the 1950s and 1960s, computers were enormous machines affordable only by large institutions. Now they come in a variety of shapes and sizes, which can be classified according to their processing power: *supercomputers, mainframe computers, workstations, microcomputers,* and *microcontrollers*. We also consider *servers*.



Supercomputer Maker or Lab	Top Speed, Teraflops	Location
Roadrunner Los Alamos Laboratory and IBM	1,105	U.S.
Blue Gene/L IBM	280.6	U.S.
Molecular Dynamics Machine Riken	78	Japan
Grape-6 U. Tokyo	64	Japan
Columbia SGI	61	U.S.
Earth Simulator NEC	41	Japan

Source: Data from *www.top500.org,* reported in Don Clark, "Los Alamos Computer Keeps Title as the Fastest," *The Wall Street Journal,* November 11, 2008, p. B9; *www.newsfactor.com/story.xhtml?story_id=31771; www.supercomputingonline.com/print.php?sid=8879;* and H. Josef Hebert, "Computer Proves It's World's Fastest," *San Francisco Chronicle,* June 10, 2008, p. 47.

panel 1.6

more info!

FLOPS

In computing, FLOPS is an abbreviation of Floating-point Operations Per Second. Flops is used as a measure of a computer's performance, especially in fields of scientific calculations. Using floating-point encoding, extremely long numbers can be handled relatively easily. Computers operate in the trillions of flops; for comparison, any response time below 0.1 second is experienced as instantaneous by a human operator, so a simple pocket calculator could be said to operate at about 10 flops. Humans are even worse floating-point processors. If it takes a person a quarter of an hour to carry out a pencil-and-paper long division with 10 significant digits, that person would be calculating in the milliflops range.

Supercomputers

Is there a chance I might use a supercomputer?

Typically priced from $1 million to more than $350 million, ***supercomputers*** **are high-capacity machines with thousands of processors that can perform more than several trillion calculations per second.** These are the most expensive and fastest computers available. "Supers," as they are called, have been used for tasks requiring the processing of enormous volumes of data, such as doing the U.S. census count, forecasting weather, designing aircraft, modeling molecules, and breaking encryption codes. More recently they have been employed for business purposes—for instance, sifting demographic marketing information—and for creating film animation. The fastest computer in the world, costing $100 million and with roughly the computing power of 100,000 of today's most powerful laptops, is the Roadrunner, developed by engineers from the Los Alamos National Laboratory and IBM Corp., primarily for nuclear weapons research, including simulating nuclear explosions. Roadrunner's speed is 1.105 petaflops, or 1,105 trillion operations per second.[60] *(● See Panel 1.6.)* In February 2009, IBM announced its intent to release "Sequoia," a 20 petaflops supercomputer, in 2011. This machine will have the power of approximately 2 million laptops.

Roadrunner supercomputer from Los Alamos National Laboratory and IBM This is the world's fastest supercomputer.

1984	1994	1998	2000	2001	2002	2003
Apple Macintosh; first personal laser printer	Apple and IBM introduce PCs with full-motion video built in; wireless data transmission for small portable computers; first web browser invented	PayPal is founded	The "Y2K" nonproblem; the first U.S. presidential webcast	Dell computers becomes the largest PC maker	Friendster	Facebook MySpace

Mainframe computer

Supercomputers are still the most powerful computers, but a new generation may be coming that relies on ***nanotechnology*, in which molecule-size nanostructures are used to create tiny machines for holding data or performing tasks.** (*Nano* means "one-billionth.") Computers the size of a pencil eraser could become available that work 10 times faster than today's fastest supercomputer.[61] Eventually nanotech could show up in every device and appliance in your life.

Mainframe Computers

What kind of services am I apt to get from a mainframe?

The only type of computer available until the late 1960s, ***mainframes*** **are water- or air-cooled computers that cost $5,000–$5 million and vary in size from small, to medium, to large, depending on their use.** Small mainframes ($5,000–$200,000) are often called *midsize computers;* they used to be called *minicomputers,* although today the term is seldom used. Mainframes are used by large organizations—such as banks, airlines, insurance companies, and colleges—for processing millions of transactions. Often users access a mainframe by means of a ***terminal*, which has a display screen and a keyboard and can input and output data but cannot by itself process data.** Mainframes process billions of instructions per second.

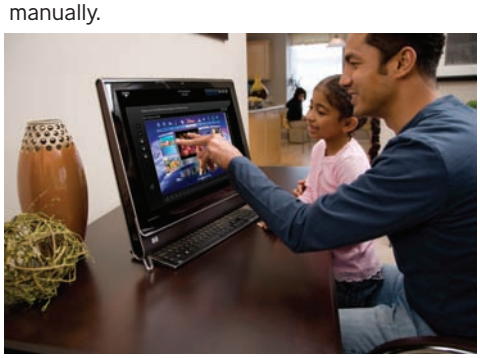
Workstation

Workstations

What are some uses of workstations?

Introduced in the early 1980s, ***workstations*** **are expensive, powerful personal computers usually used for complex scientific, mathematical, and engineering calculations and for computer-aided design and computer-aided manufacturing.** Providing many capabilities comparable to those of midsize mainframes, workstations are used for such tasks as designing airplane fuselages, developing prescription drugs, and creating movie special effects. Workstations have caught the eye of the public mainly for their graphics capabilities, which are used to breathe three-dimensional life into movies such as *WALL • E, Harry Potter,* and *X-Men Origins: Wolverine.* The capabilities of low-end workstations overlap those of high-end desktop microcomputers.

Hewlett-Packard Touchsmart
This desktop computer allows users to move items around on the screen with their hands, to open and close files, and to perform other functions manually.



Microcomputers

How does a microcomputer differ from a workstation?

***Microcomputers*, also called *personal computers* (*PCs*), which cost $500 to over $5,000, can fit next to a desk or on a desktop or can be carried around.** They either are stand-alone machines or are connected to a computer network, such as a local area network. **A *local area network (LAN)* connects, usually by special cable, a group of desktop PCs and other devices, such as printers, in an office or a building.**

Microcomputers are of several types: desktop PCs, tower PCs, notebooks (laptops), netbooks, mobile internet devices (MIDs), and personal digital assistants—handheld computers or palmtops.

2004	2005	2006	2007	2012	2030–2045
IBM PC sold to Lenovo Group Flickr	YouTube Wii	Twitter	Skype	Foldable computers	The Singularity

Small The Mac Mini has the smallest desktop microcomputer case, just 6.5 inches square and 2 inches tall.

DESKTOP PCs ***Desktop PCs*** *(left)* **are older microcomputers whose case or main housing sits on a desk, with keyboard in front and monitor (screen) often on top.**

TOWER PCs ***Tower PCs*** **are microcomputers whose case sits as a "tower," often on the floor beside a desk, thus freeing up desk surface space.** Some desktop computers, such as Apple's iMac, no longer have a boxy housing; most of the computer components are built into the back of the flat-panel display screen.

Tower PC

Notebook computers: Macbooks

NOTEBOOKS ***Notebook computers*****, also called** ***laptop computers*****, are lightweight portable computers with built-in monitor, keyboard, hard-disk drive, CD/DVD drive, battery, and AC adapter that can be plugged into an electrical outlet; they weigh anywhere from 1.8 to 9 pounds.**

NETBOOKS A fairly recent category, ***netbooks*** **are low-cost, lightweight, computers with tiny dimensions and functions designed for basic tasks, such as web searching, email, and word processing.** They weigh anywhere from 2.25 to 3.2 pounds, cost generally between $270 and $500, have little processing power, and have screens between 8.9 and 12 inches wide diagonally.[62] Netbooks fill a technological category between notebooks and handheld devices.

Netbook

LG Mobile Internet Device (MID)

MOBILE INTERNET DEVICES (MIDs) Smaller than notebook computers but larger and more powerful than PDAs (see below), ***mobile internet devices (MIDs)*** **are for consumers and business professionals.** Fully internet integrated, they are highly compatible with desktop microcomputers and laptops. The initial models focus on data communication, not voice communication.

Personal digital assistant (PDA)

PERSONAL DIGITAL ASSISTANTS ***Personal digital assistants (PDAs)*****, also called** ***handheld computers*** **or** ***palmtops*****, combine personal organization tools—schedule planners, address books, to-do lists—with the ability in some cases to send email and faxes.** Some PDAs have touch-sensitive screens. Some also connect to desktop computers for sending or receiving information. (For now, we are using the word *digital* to mean "computer based.") The range of handheld wireless devices, such as multipurpose cellphones, has surged in recent years, and we consider these later in the book (Chapter 7).

Microcontrollers

What gadgets do I have that might contain microcontrollers?

Microcontrollers**, also called** ***embedded computers*****, are the tiny, specialized microprocessors installed in "smart" appliances and automobiles.** These microcontrollers enable microwave ovens, for example, to store data about how long to cook your potatoes and at what power setting. Microcontrollers have been used to develop a new universe of experimental electronic

Microcontroller The MPXY8020A pressure sensor from Motorola reduces tire blowouts and improves gas mileage. This embedded computer notifies drivers, via a dashboard display, when tire pressure is not optimal.

appliances—e-pliances. For example, they are behind single-function products such as digital cameras, MP3 and MP4 players, and organizers, which have been developed into hybrid forms such as gadgets that store photos and videos as well as music. They also help run tiny web servers embedded in clothing, jewelry, and household appliances such as refrigerators. In addition, microcontrollers are used in blood-pressure monitors, air bag sensors, gas and chemical sensors for water and air, and vibration sensors.

Servers

How do servers work, and what do they do?

Cellphone microcontroller

The word *server* describes not a size of computer but rather a particular way in which a computer is used. Nevertheless, because servers have become so important to telecommunications, especially with the rise of the internet and the web, they deserve mention here. (Servers are discussed in detail in Chapters 2, 6, and 7.)

A *server*, or *network server*, is a central computer that holds collections of data (databases) and programs for connecting or supplying services to PCs, workstations, and other devices, which are called *clients*. These clients are linked by a wired or wireless network. The entire network is called a *client/server network*. In small organizations, servers can store files, provide printing stations, and transmit email. In large organizations, servers may also house enormous libraries of financial, sales, and product information.

You may never lay eyes on a supercomputer or mainframe or even a tiny microcontroller. But most readers of this book will already have laid eyes and hands on a personal computer. We consider this machine next.

Servers A group of networked servers that are housed in one location is called a *server farm* or a *server cluster.*

I.5 UNDERSTANDING YOUR COMPUTER: How Can You Customize (or Build) Your Own PC?

What four basic operations do all computers use, and what are some of the devices associated with each operation? How does communications affect these operations?

Perhaps you know how to drive a car. But do you know what to do when it runs badly? Similarly, you've probably been using a personal computer. But do you know what to do when it doesn't act right—when, for example, it suddenly "crashes" (shuts down)?

Cars are now so complicated that professional mechanics are often required for even the smallest problems. With personal computers, however, there are still many things you can do yourself—and should learn to do, so that, as we've suggested, you can be effective, efficient, and employable. To do so, you first need to know how computers work.

How Computers Work: Three Key Concepts

What are the three fundamental principles everyone should understand about how computers work?

Could you build your own personal computer? Some people do, putting together bare-bones systems for just a few hundred dollars. "If you have a logical mind, are fairly good with your hands, and possess the patience of Job, there's no reason you can't . . . build a PC," says science writer David Einstein. And, if you do it right, "it will probably take only a couple of hours," because industry-standard connections allow components to go together fairly easily.[63]

Actually, probably only techies would consider building their own PCs. But many ordinary users *order* their own custom-built PCs. Let's consider how you might do this.

We're not going to ask you to build or order a PC—just to pretend to do so. The purpose of this exercise is to give you a basic overview of how a computer works. That information will help you when you go shopping for a new system or, especially, if you order a custom-built system. It will also help you understand how your existing system works, if you have one.

Before you begin, you will need to understand three key concepts.

1. PURPOSE OF A COMPUTER: TURNING DATA INTO INFORMATION Very simply, the purpose of a computer is to process data into information.

- **Data: *Data* consists of the raw facts and figures that are processed into information**—for example, the votes for different candidates being elected to student-government office.
- **Information: *Information* is data that has been summarized or otherwise manipulated for use in decision making**—for example, the total votes for each candidate, which are used to decide who won.

2. DIFFERENCE BETWEEN HARDWARE & SOFTWARE You should know the difference between hardware and software.

- **Hardware: *Hardware* consists of all the machinery and equipment in a computer system.** The hardware includes, among other devices, the keyboard, the screen, the printer, and the "box"—the computer or processing device itself. Hardware is useless without software.
- **Software: *Software*, or *programs*, consists of all the electronic instructions that tell the computer how to perform a task.** These instructions come from a software developer in a form (such as a CD, or compact disk) that will be accepted by the computer. Examples are Microsoft Windows and Office XP/Vista.

3. THE BASIC OPERATIONS OF A COMPUTER Regardless of type and size, all computers use the same four basic operations: (1) input, (2) processing, (3) storage, and (4) output. To this we add (5) communications.

Survival Tip

Input is covered in detail in Chapter 5.

- **Input operation: *Input* is whatever is put in ("input") to a computer system.** Input can be nearly any kind of data—letters, numbers, symbols, shapes, colors, temperatures, sounds, pressure, light beams, or whatever raw material needs processing. When you type some words or numbers on a keyboard, those words are considered input data.

Survival Tip

Processing is covered in detail in Chapter 4.

- **Processing operation: *Processing* is the manipulation a computer does to transform data into information.** When the computer adds 2 + 2 to get 4, that is the act of processing. The processing is done by the *central processing unit*—frequently just called the *CPU*—a device consisting of electronic circuitry that executes instructions to process data.

Survival Tip

Storage is covered in detail in Chapter 4.

- **Storage operation:** Storage is of two types—temporary storage and permanent storage, or primary storage and secondary storage. ***Primary storage*, or *memory*, is the internal computer circuitry that temporarily holds data waiting to be processed. *Secondary storage*, simply called *storage*, refers to the devices and media that store data or information permanently.** A hard disk or CD/DVD is an example of this kind of storage. (Storage also holds the software—the computer programs.)

Survival Tip

Output is covered in detail in Chapter 5.

- **Output operation: *Output* is whatever is output from ("put out of") the computer system—the results of processing, usually information.** Examples of output are numbers or pictures displayed on a screen, words printed out on paper by a printer, or music piped over some loudspeakers.

Survival Tip

Communications is covered in detail in Chapters 2, 6, and 7.

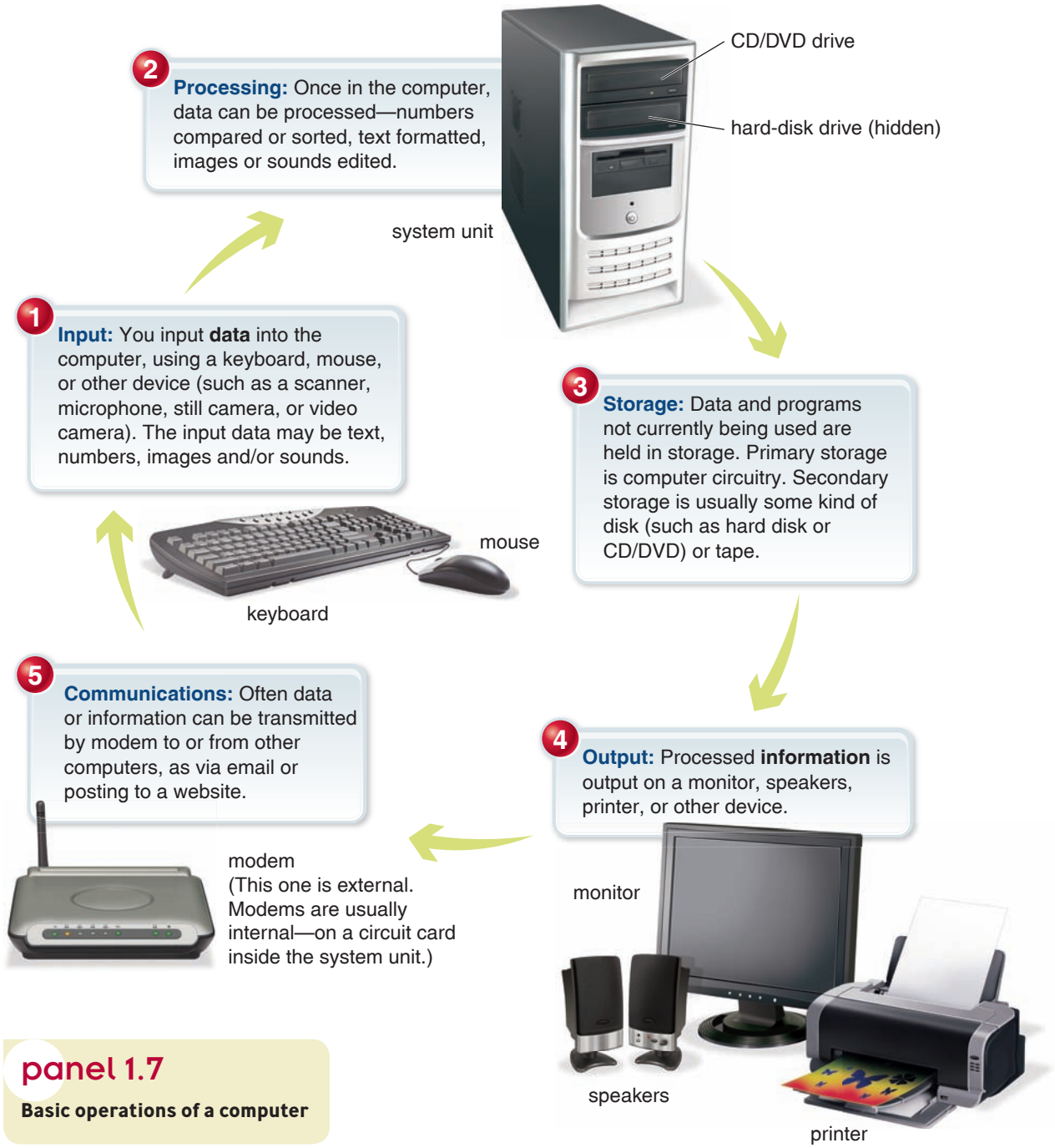
- **Communications operation:** These days, most (though not all) computers have communications ability, which offers an extension capability—in other words, it extends the power of the computer. With wired or wireless communications connections, data may be input from afar, processed in a remote area, stored in several different locations, and output in yet other places. However, you don't need communications ability to write letters, do calculations, or perform many other computer tasks.

These five operations are summarized in the illustration on the facing page. *(● See Panel 1.7.)*

Pretending to Order (or Build) a Custom-Built Desktop Computer: Basic Knowledge of How a Computer Works

In what order would components be put together to build a custom desktop computer?

Now let's see how you would order a custom-built desktop PC, or even build one yourself. Remember, the purpose of this is to help you understand the internal workings of a computer so that you'll be knowledgeable about using one and buying one. (If you were going to build it yourself, you would pretend that someone had acquired the PC components for you from a catalog company and that you're now sitting at a table about to begin assembling them. All you would need is a combination Phillips/flathead screwdriver, perhaps a small wrench, and a static-electricity-arresting strap for your wrist, to keep static electricity from adversely affecting some computer components. You would also need the manuals that come with some of the components.) Although prices of components are always subject to change, we have indicated general ranges of prices for basic equipment current as of 2009 so that you can get a sense of the relative importance of the various parts. ("Loaded" components—the most powerful and sophisticated equipment—cost more than the prices given here.)



panel 1.7
Basic operations of a computer

Note: All the system components you or anyone else chooses *must be compatible*—in other words, each brand must work with other brands. If you work with one company—such as Dell, or Hewlett-Packard—to customize your system, you won't have to worry about compatibility. If you choose all the components yourself—for example, by going to a computer-parts seller such as ComputerGeeks.com (*www.geeks.com*)—you will have to check on compatibility as you choose each component. And you'll have to make sure each component comes with any necessary cables, instructions, and component-specific software (called a *driver*) that makes the component run.

This section of the chapter gives you a brief overview of the components, which are all covered in detail in Chapters 2–6. We describe them in the following order: (1) input hardware—keyboard and mouse; (2) processing and memory hardware; (3) storage hardware—disk drives; (4) output hardware—video and sound cards, monitor, speakers, and printer; (5) communication hardware—the modem; and (6) software—system and application.

Survival Tip

Hardware Info

Go to *http://computers.bizrate.com/computers_software/* for a listing of virtually all types of hardware, their descriptions, ratings, and prices, and the names of sellers.

Input Hardware: Keyboard & Mouse

What do the two principal input devices, keyboard and mouse, do?

Input hardware consists of devices that allow people to put data into the computer in a form that the computer can use. At minimum, you will need two things: a *keyboard* and a *mouse*.

KEYBOARD (Cost: $5–$100) On a microcomputer, a keyboard is the primary input device. **A *keyboard* is an input device that converts letters, numbers, and other characters into electrical signals readable by the processor.** A microcomputer keyboard looks like a typewriter keyboard, but besides having keys for letters and numbers it has several keys (such as *F* keys and *Ctrl, Alt,* and *Del* keys) intended for computer-specific tasks. After other components are assembled, the keyboard will be plugged into the back of the computer in a socket intended for that purpose. (Cordless keyboards work differently.)

Keyboard

Mouse

MOUSE ($5–$50) **A *mouse* is a nonkeyboard input device ("pointing device") that is used to manipulate objects viewed on the computer display screen.** The mouse cord is plugged into the back of the computer or into the back of the keyboard after the other components are assembled. (Cordless mice are also available.)

Processing & Memory Hardware: Inside the System Cabinet

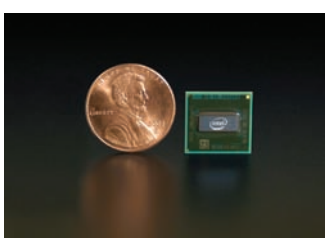
How do I distinguish the processing and memory devices in a computer? What does the motherboard do?

The brains of the computer are the *processing* and *memory* devices, which are installed in the case or system cabinet.

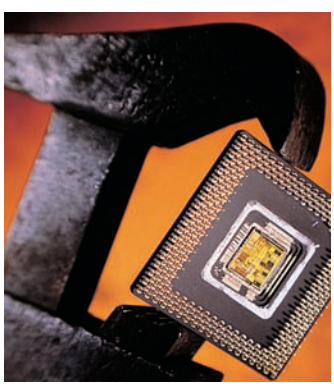
Case

CASE & POWER SUPPLY (about $10–$200) **Also known as the *system unit*, the *case* or *system cabinet* is the box that houses the processor chip (CPU), the memory chips, and the motherboard with power supply, as well as some secondary-storage devices**—floppy-disk drive (if any), hard-disk drive, and CD or DVD drive, as we will explain. The case generally comes in desktop or tower models. It includes a power supply unit and a fan to keep the circuitry from overheating.

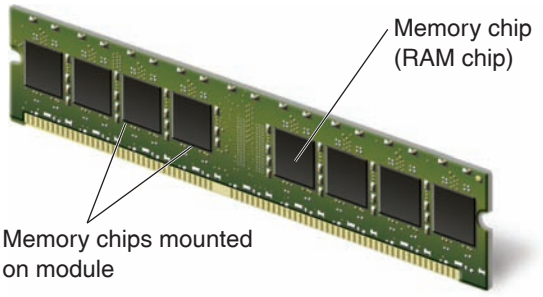
PROCESSOR CHIP ($20–$1,000 or more) It may be small and not look like much, but it could be the most expensive hardware component of a build-it-yourself PC—and doubtless the most important. **A *processor chip (CPU, for central processing unit)* is a tiny piece of silicon that contains millions of miniature electronic circuits.** The speed at which a chip processes information is expressed in *megahertz (MHz),* millions of processing cycles per second, or *gigahertz (GHz),* billions of processing cycles per second. The faster the processor, the more expensive it is. For $50, you might get a 2-GHz chip, which is adequate for most student purposes. For $100, you might get a 3-GHz chip, which you would want if you're running software with spectacular graphics and sound, such as those with some new videogames. Only older processors' speed is measured in megahertz now, but if you want a cheap processor—for instance, because you plan to work only with text documents—you could get a 233-MHz processor for about $40.



Processor chip



MEMORY CHIPS ($20–$600) These chips are also small. ***Memory chips*, also known as *RAM (random access memory) chips*, represent *primary* storage, or temporary storage; they hold data before processing and information after processing, before it is sent along to an output or storage device.** You'll want enough memory chips to hold at least 1 gigabyte, or roughly 1 billion characters, of data, which is adequate for most student purposes. If you work with large graphics files, you'll need more memory capacity, perhaps 2 gigabytes or more. (We will explain the numbers used to measure storage capacities in a moment.)



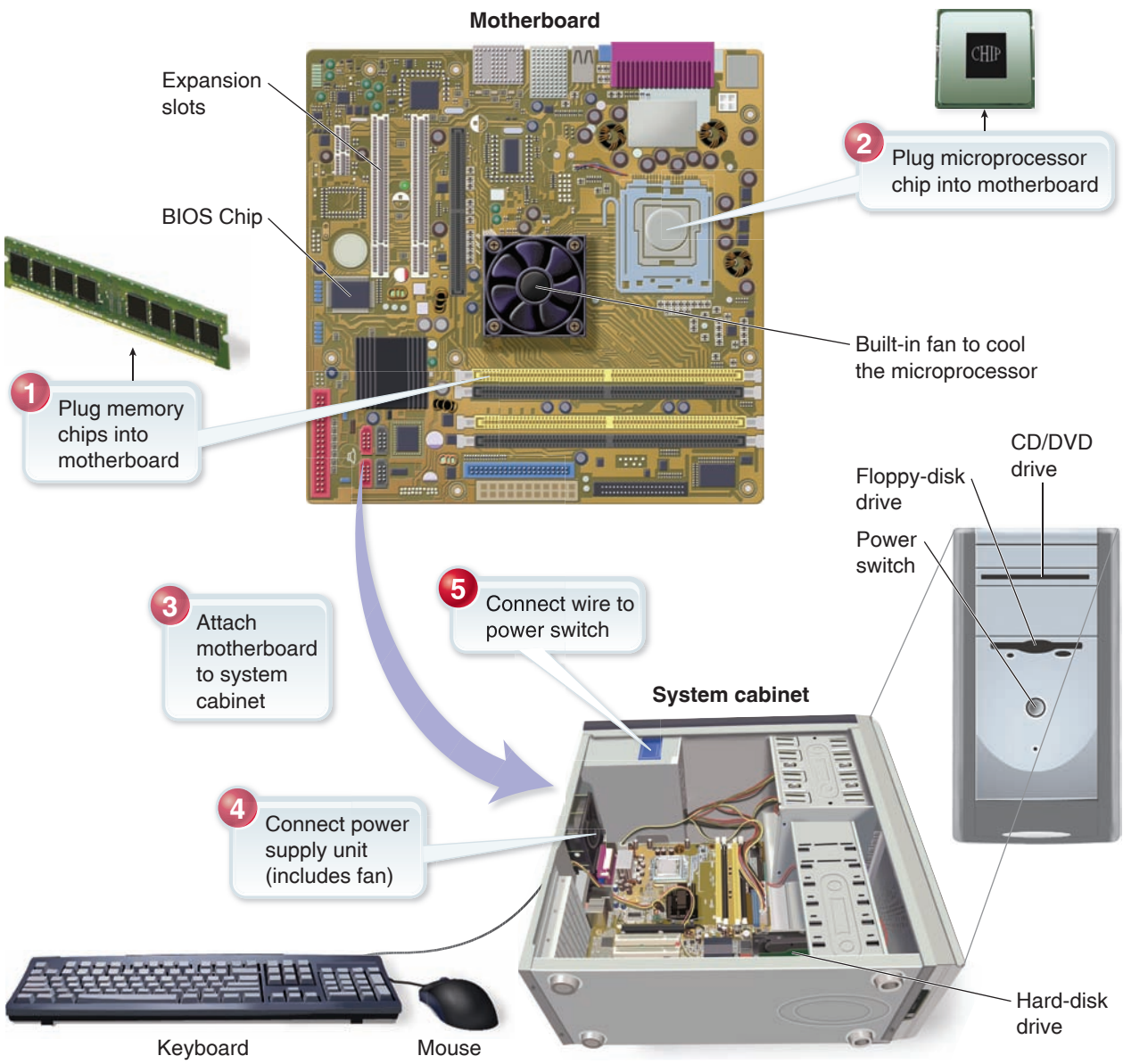
(Memory chip)

MOTHERBOARD (about $45–$500) **Also called the *system board*, the *motherboard* is the main circuit board in the computer.** This is the big green circuit board to which everything else—such as the keyboard, mouse, and printer—attaches through connections (called *ports*) in the back of the computer. The processor chip and memory chips are also installed on the motherboard.

The motherboard has ***expansion slots*—for expanding the PC's capabilities—which give you places to plug in additional circuit boards,** such as those for video, sound, and communications (modem). *(● See Panel 1.8.)*

panel 1.8

Putting the components together



PUTTING THE COMPONENTS TOGETHER Now the components can be put together. As the illustration on the previous page shows, ❶ the memory chips are plugged into the motherboard. Then ❷ the processor chip is plugged into the motherboard. Now ❸ the motherboard is attached to the system cabinet. Then ❹ the power supply unit is connected to the system cabinet. Finally, ❺ the wire for the power switch, which turns the computer on and off, is connected to the motherboard.

Storage Hardware: Hard Drive & CD/DVD Drive

What kind of storage devices would I as a student probably want in my computer?

With the motherboard in the system cabinet, the next step is installation of the storage hardware. Whereas memory chips deal only with temporary storage, *secondary storage,* or *permanent storage,* stores your data for as long as you want.

For today's student purposes, you'll need a hard drive and a CD/DVD drive, and in older systems (called *legacy systems*), you might have a floppy disk drive. These storage devices slide into the system cabinet from the front and are secured with screws. Each drive is attached to the motherboard by a flat cable (called a *ribbon cable*). Also, each drive must be hooked up to a plug extending from the power supply.

A computer system's data/information storage capacity is represented by bytes, kilobytes, megabytes, gigabytes, terabytes, and petabytes, as follows:

1 byte = *1 character of data* (A character can be alphabetic—A, B, or C—or numeric—1, 2, or 3—or a special character—!, ?, *, $, %.)
1 kilobyte = *1,024 characters*
1 megabyte = *1,048,576 characters*
1 gigabyte = *more than 1 billion characters*
1 terabyte = *more than 1 trillion characters*
1 petabye = *about 1 quadrillion characters*

FLOPPY-DISK DRIVE ($25) A *floppy-disk drive* is a storage device that stores data on removable 3.5-inch-diameter diskettes. These diskettes, which are now used mostly on fairly old microcomputer systems, don't seem to be "floppy," because they are encased in hard plastic, but the mylar disk inside is indeed flexible or floppy. Each can store 1.44 million bytes (characters) or more of data. With a floppy-disk drive installed, you'll later be able to insert a diskette through a slot in the front and remove it by pushing the eject button.

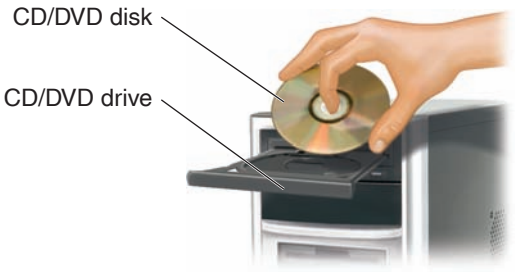

Floppy disk

HARD-DISK DRIVE ($35–$200, depending on storage capacity) **A *hard-disk drive* is a storage device that stores billions of characters of data on a nonremovable disk platter.** With 120–200 gigabytes of storage (about $40), you should be able to handle most student needs. (Some hard-disk drives store up to 2 terabytes of data.)


Hard-disk drive (goes inside the computer case)

CD/DVD DRIVE ($30–$180) **A *CD (compact-disk) drive*, or its more recent variant, a *DVD (digital video-disk) drive*, is a storage device that uses laser technology to read data from optical disks.** (Some companies call a DVD a "digital versatile disk.") Today new software is generally supplied on CDs or via the net.

The system cabinet has lights on the front that indicate when these drives are in use. (You must not remove a disk from the drive until its light goes off, or else you risk damage to both disk and drive.) The wires for these lights need to be attached to the motherboard.



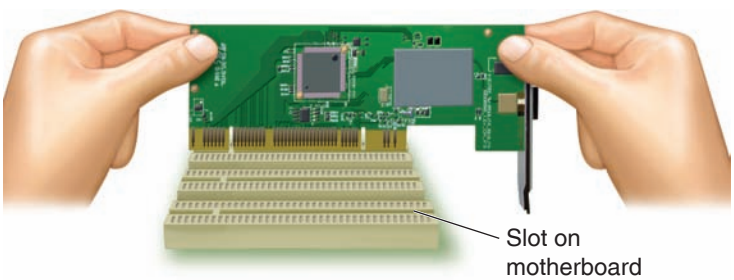
Output Hardware: Video & Sound Cards, Monitor, Speakers, & Printer

What kinds of output hardware are standard with a PC?

Output hardware consists of devices that translate information processed by the computer into a form that humans can understand—print, sound, graphics, or video, for example. Now a video card and a sound card need to be installed in the system cabinet. Next the monitor, speakers, and a printer are plugged in.

This is a good place to introduce the term *peripheral device*. **A *peripheral device* is any component or piece of equipment that expands a computer's input, storage, and output capabilities.** In other words, a peripheral device is not part of the essential computer. Peripheral devices can be inside the computer or connected to it from the outside. Examples include printers and disk drives.

VIDEO CARD ($30–$1,400) You doubtless want your monitor to display color (rather than just black-and-white) images. Your system cabinet will therefore need to have a device to make this possible. **A *video card* converts the processor's output information into a video signal that can be sent through a cable to the monitor.** Remember the expansion slots we mentioned? Your video card is plugged into one of these on the motherboard. (You can also buy a motherboard with built-in video.)



Insert slot on motherboard

SOUND CARD ($15–$300 and higher) You may wish to listen to music on your PC. If so, you'll need a ***sound card*, which enhances the computer's sound-generating capabilities by allowing sound to be output through speakers.** This, too, would be plugged into an expansion slot on the motherboard. (Once again, you can buy a motherboard with built-in sound.) With the CD drive connected to the card, you can listen to music CDs.

MONITOR ($150–$300 or higher for a 17-inch model or a 19-inch model; $300–$1,200 or more for larger displays) As with television sets, the inch dimension on monitors is measured diagonally corner to corner. **The *monitor* is the display device that takes the electrical signals from the video card and forms an image using points of colored light on the screen.** Later, after the system cabinet has been closed up, the monitor will be connected by means of a cable to the back of the computer, using the clearly marked connector. The power cord for the monitor will be plugged into a wall plug.


Monitor

Speakers

PAIR OF SPEAKERS ($25–$250) ***Speakers*** **are the devices that play sounds transmitted as electrical signals from the sound card.** They may not be very sophisticated, but unless you're into high-fidelity recordings they're probably good enough. The two speakers are connected to a single wire that is plugged into the back of the computer once installation is completed.

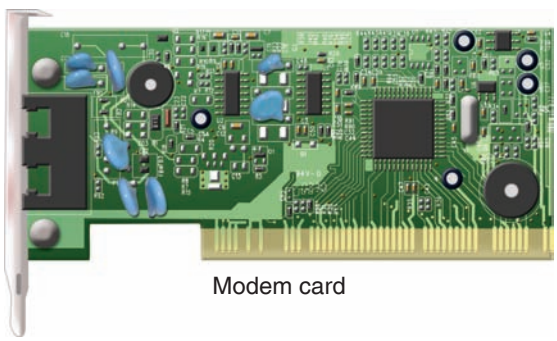
Printer

PRINTER ($50–$1,000) Especially for student work, you certainly need a ***printer,*** **an output device that produces text and graphics on paper.** There are various types of printers, as we discuss later. The printer has two connections. One, which relays signals from the computer, goes to the back of the PC, where it connects with the motherboard. The other is a power cord that goes to a wall plug. Color printers are more expensive than black-and-white printers, and fast printers cost more than slow ones.

Communications Hardware: Modem

How is a modem installed?

Computers can be stand-alone machines, unconnected to anything else. If all you're doing is word processing to write term papers, you can do it with a stand-alone system. As we have seen, however, the communications component of the computer system vastly extends the range of a PC. Thus, while the system cabinet is still open, there is one more piece of hardware to install.



Modem card

MODEM ($10–$100) **A standard *modem* is a device that sends and receives data over telephone lines to and from computers.** The modem is mounted on an expansion card, which is fitted into an expansion slot on the motherboard. Later you can run a telephone line from the telephone wall plug to the back of the PC, where it will connect to the modem.

Other types of communications connections exist, which we cover in Chapters 2 and 6. However, standard modems are still often used.

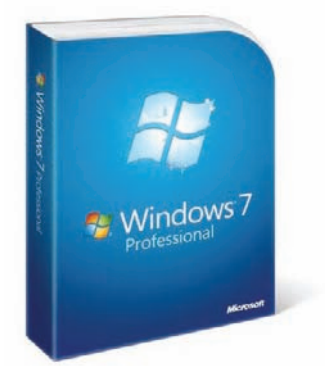
Now the system cabinet is closed up. The person building the system will plug in all the input and output devices and turn on the power "on" button. Your microcomputer system will look similar to the one opposite. *(● See Panel 1.9.)* Are you now ready to roll? Not quite.

System software—a version of Microsoft Vista

Software

In what order are the two kinds of software installed?

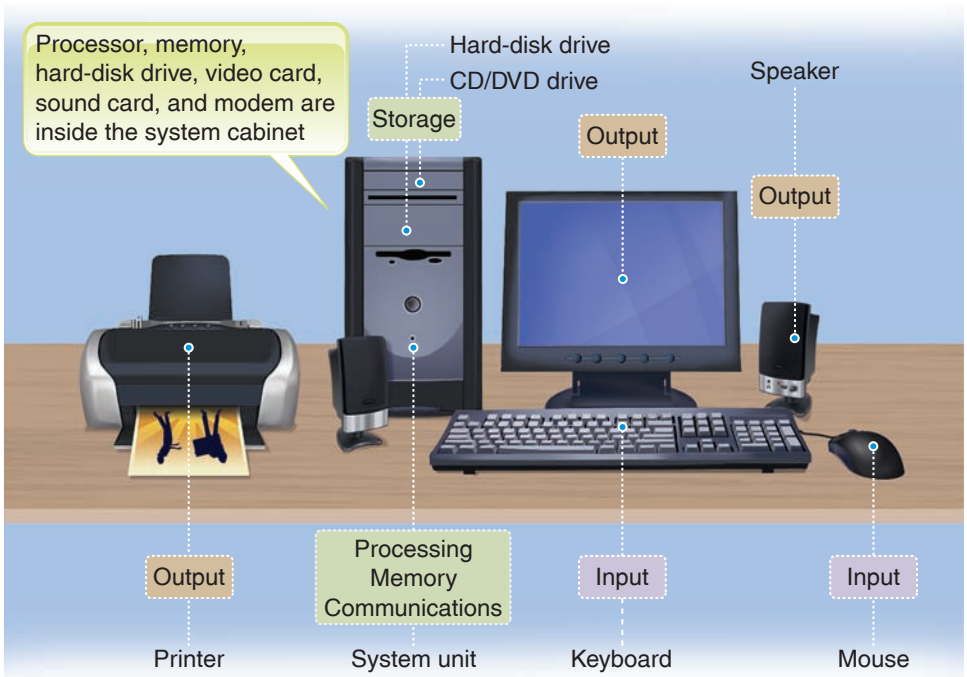
With all the pieces put together, the person assembling the computer (you, if you're building it yourself) needs to check the motherboard manual for instructions on starting the system. One of the most important tasks is to install software, the electronically encoded instructions that tell the computer hardware what to do. Software is what makes the computer worthwhile. There are two types—*system software* and *application software.*



System software—a version of Microsoft 7

SYSTEM SOFTWARE First, system software must be installed. ***System software*** **helps the computer perform essential operating tasks and enables the application software to run.** System software consists of several electronically coded programs. The most important is the *operating system,* the master control program that runs the computer. Examples of operating system software for the PC are various Microsoft programs (such as Windows 95, 98, XP, Vista, and 7), Unix, and Linux. The Apple Macintosh microcomputer is another matter altogether. As we explain in Chapter 3, it has its own hardware components and software, which often aren't directly transferable to the PC.

System software comes most often on CDs. The person building your computer system will insert these into your CD drive and follow the on-screen



panel 1.9
Completely assembled PC hardware system

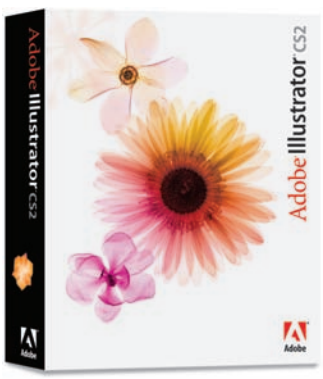
directions for installation. (*Installation* is the process of copying software programs from secondary-storage media—CDs, for example—onto your system's hard disk, so that you can have direct access to your hardware.)

After the system software is installed, setup software for the hard drive, the video and sound cards, and the modem must be installed. These setup programs (*drivers,* discussed in Chapter 3) will probably come on CDs. Once again, the installer inserts these into the appropriate drive and then follows the instructions that appear on the screen.

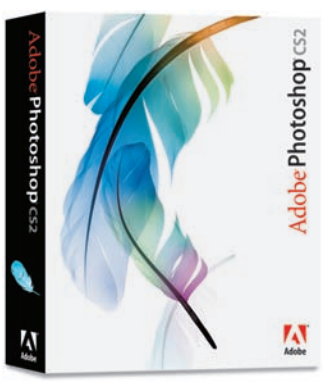
APPLICATION SOFTWARE Now we're finally getting somewhere! After the application software has been installed, you can start using the PC. ***Application software*** **enables you to perform specific tasks—solve problems, perform work, or entertain yourself.** For example, when you prepare a term paper on your computer, you will use a word processing program. (Microsoft Word and Corel WordPerfect are two brands.) Application software is specific to the system software you use. If you want to run Microsoft Word, for instance, you'll need to first have Microsoft Windows system software on your system, not Unix or Linux.

Application software comes on CDs packaged in boxes that include instructions. You insert the CDs into your computer and then follow the instructions on the screen for installation. Later on you may obtain entire application programs by getting (downloading) them off the internet, using your modem or another type of communications connection.

We discuss software in more detail in Chapter 3.



Application software for rendering art



Application software for photo manipulation

Is Getting a Custom-Built PC Worth the Effort?

Why might I want to build a PC myself—and why not?

Does the foregoing description make you want to try putting together a PC yourself? If you add up the costs of all the components (not to mention the value of your time), and then start checking ads for PCs, you might wonder why anyone would bother going to the trouble of building one. And nowadays you would probably be right. "If you think you'd save money by putting together a computer from scratch," says David Einstein, "think again. You'd be lucky to match the price PC-makers are charging these days in their zeal to undercut the competition."[64]

But had you done this for real, it would not have been a wasted exercise: by knowing how to build a system yourself, not only would you be able to impress your friends but you'd also know how to upgrade any store-bought system to include components that are better than standard. For instance, as Einstein points out, if you're into videogames, knowing how to construct your own PC would enable you to make a system that's right for games. You could include the latest three-dimensional graphics video card and a state-of-the-art sound card, for example. More important, you'd also know how to order a custom-built system (as from Dell, Hewlett-Packard, Lenovo, or Gateway, some of the online computer makers) that's right for you. In Chapters 4 and 5, we'll expand on this discussion so that you can really know what you're doing when you go shopping for a microcomputer system.

I.6 Where Is Information Technology Headed?

What are three directions of computer development and three directions of communications development?

How far we have come. At the beginning of the 20th century, most people thought they would live the same life their parents did. Today most people aren't surprised by the prediction that the Information Age will probably transform their lives beyond recognition. Let's consider the trends in the development of computers and communications and, most exciting, the area where they intersect.

Three Directions of Computer Development: Miniaturization, Speed, & Affordability

What are the three ways computers have developed?

Since the days of ENIAC, computers have developed in three directions—and are continuing to do so.

Miniaturization A woman tries on a prototype of a wearable computer, a jacket with a built-in display in its sleeve. This type of computer, from Pioneer, is expected to aid medical workers, firefighters, and farm workers.

MINIATURIZATION Everything has become smaller. ENIAC's old-fashioned radio-style vacuum tubes gave way after 1947 to the smaller, faster, more reliable transistor. A *transistor* is a small device used as a gateway to transfer electrical signals along predetermined paths (circuits).

The next step was the development of tiny *integrated circuits*. Integrated circuits are entire collections of electrical circuits or pathways that are now etched on tiny squares (chips) of silicon half the size of your thumbnail. *Silicon* is a natural element found in sand. In pure form, it is the base material for computer processing devices.

The miniaturized processor, or microprocessor, in a personal desktop computer today can perform calculations that once required a computer filling an entire room.

SPEED Thanks to miniaturization and new material used in making processors, computer makers can cram more hardware components into their machines, providing faster processing speeds and more data storage capacity.

AFFORDABILITY Processor costs today are only a fraction of what they were 15 years ago. A state-of-the-art processor costing less than $1,000 provides the same processing power as a huge 1980s computer costing more than $1 million.

These are the three major trends in computers. What about communications?

Three Directions of Communications Development: Connectivity, Interactivity, & Multimedia

What are three things I do that represent these three features—connectivity, interactivity, and multimedia?

Once upon a time, we had the voice telephone system—a one-to-one medium. You could talk to your Uncle Joe and he could talk to you, and with special arrangements (conference calls) more than two people could talk with one another. We also had radio and television systems—one-to-many media (or mass media). News announcers could talk to you on a single medium such as television, but you couldn't talk to them.

There have been three recent developments in communications:

CONNECTIVITY ***Connectivity*** **refers to the connection of computers to one another by a communications line in order to provide online information access and/or the sharing of peripheral devices.** The connectivity resulting from the expansion of computer networks has made possible email and online shopping, for example.

INTERACTIVITY ***Interactivity*** **refers to two-way communication; the user can respond to information he or she receives and modify what a computer is doing.** That is, there is an exchange or dialogue between the user and the computer, and the computer responds to user requests. A noninteractive program, once started, continues without requiring human contact, or interaction. The ability to interact means users can be active rather than passive participants in the technological process. On the television networks MSNBC or CNN, for example, you can immediately go on the internet and respond to news from broadcast anchors. Today, most application software is interactive. In the future, cars may respond to voice commands or feature computers built into the dashboard.

Interactivity A dashboard computer allows drivers to request information about the car's operation, location, and nearby services.

MULTIMEDIA Radio is a single-dimensional medium (sound), as is most email (mainly text). As mentioned earlier in this chapter, ***multimedia*** **refers to technology that presents information in more than one medium—such as text, pictures, video, sound, and animation—in a single integrated communication.** The development of the World Wide Web expanded the internet to include pictures, sound, music, and so on, as well as text.

Exciting as these developments are, truly mind-boggling possibilities have emerged as computers and communications have cross-pollinated.

When Computers & Communications Combine: Convergence, Portability, Personalization, Collaboration, & Cloud Computing

What are five developments growing out of the fusion of computers and communications?

Sometime in the 1990s, computers and communications started to fuse together, beginning a new era within the Information Age. The result has been five additional developments.

CONVERGENCE *Convergence* describes the combining of several industries through various devices that exchange data in the format used by computers.

According to inventor and futurist Raymond Kuzweil, technological change will become so rapid and so profound that human bodies and brains will merge with machines.

The industries are computers, communications, consumer electronics, entertainment, and mass media. Convergence has led to electronic products that perform multiple functions, such as TVs with internet access, cellphones that are also digital cameras, and a refrigerator that allows you to send email.

PORTABILITY In the 1980s, portability, or mobility, meant trading off computing power and convenience in return for smaller size and weight. Today, however, we are close to the point where we don't have to give up anything. As a result, experts have predicted that small, powerful, wireless personal electronic devices will transform our lives far more than the personal computer has done so far. "The new generation of machines will be truly personal computers, designed for our mobile lives," wrote one journalist back in 1992. "We will read office memos between strokes on the golf course and answer messages from our children in the middle of business meetings."[65] Today such activities are commonplace, and smartphones are taking on other functions. The risk they bring is that, unless we're careful, work will completely invade our personal time.[66]

PERSONALIZATION Personalization is the creation of information tailored to your preferences—for instance, programs that will automatically cull recent news and information from the internet on just those topics you have designated. Companies involved in e-commerce can send you messages about forthcoming products based on your pattern of purchases, usage, and other criteria. Or they will build products (cars, computers, clothing) customized to your heart's desire.

COLLABORATION A more recent trend is mass collaboration. Says *New York Times* technology writer John Markoff, "A remarkable array of software systems makes it simple to share anything instantly, and sometimes enhance it along the way."[67] *BusinessWeek* writer Robert Hof observes that the huge numbers of people "online worldwide—along with their shared knowledge, social contacts, online reputations, computing power, and more—are rapidly becoming a collective force of unprecedented power."[68] Examples are file-sharing, photo-sharing websites, calendar-sharing services, group-edited sites called *wikis,* social networking services, and so-called citizen-journalism sites, in which average people write their own news items on the internet and comment on what other people post—an interactive, democratic form of mass media.[69] Pooled ratings, for instance, enable people to create personalized net music radio stations or Amazon.com's millions of customer-generated product reviews.

CLOUD COMPUTING: THE GLOBAL COMPUTER Not everyone agrees on exactly what "cloud computing" means.[70] Previously called *on-demand computing, grid computing,* or *software as a service,* ***cloud computing*** **basically means that, instead of storing your software or data on your own PC or your own company's computers, you store it on servers on the internet.** You don't care where the servers are located; they're out there somewhere—"in the cloud." The idea here is that companies could tap into computers as they are needed, just as they do now with the electric power grid, splitting their computing workload between data centers in different parts of the world. The hope of technology people is that companies will find cloud computing cheaper and more reliable than managing their own PCs, servers, and software.[71] (In a later chapter, we discuss an even more involved concept known as *the singularity.*)

Illuminated plastic balls meant to represent cloud computing go up and down on metal cables at the IBM stand at the CeBIT technology trade fair two days ahead of the fair's opening on March 1, 2009, in Hanover, Germany. CeBIT is the world's largest computer and IT trade fair.

"E" Also Stands for Ethics

What are the principal ethical concerns I should be conscious of in the use of information technology?

Every computer user will have to wrestle with ethical issues related to the use of information technology. ***Ethics*** **is defined as a set of moral values or principles that govern the conduct of an individual or a group.** Because ethical questions arise so often in connection with information technology, we will note them, wherever they appear in this book, with the symbol shown at left. Below, for example, are some important ethical concerns pointed out by Tom Forester and Perry Morrison in their book *Computer Ethics*.[72] These considerations are only a few of many; we'll discuss others in subsequent chapters.

ethics

SPEED & SCALE Great amounts of information can be stored, retrieved, and transmitted at a speed and on a scale not possible before. Despite the benefits, this has serious implications "for data security and personal privacy," as well as employment, Forester and Morrison say, because information technology can never be considered totally secure against unauthorized access.

UNPREDICTABILITY Computers and communications are pervasive, touching nearly every aspect of our lives. However, at this point, compared to other pervasive technologies—such as electricity, television, and automobiles—information technology seems a lot less predictable and reliable.

COMPLEXITY Computer systems are often incredibly complex—some so complex that they are not always understood even by their creators. "This," say Forester and Morrison, "often makes them completely unmanageable," producing massive foul-ups or spectacularly out-of-control costs.

Ethics and security can often be talked about in the same breath, since secure computer systems obviously go a long way toward keeping people ethical and honest. When we discuss security, you will see this icon:

SECURITY

Survival Tip

Recycling Old PCs

Just got a new computer? Where to donate your old one? Check with schools, after-school programs, churches, and the following websites:

wwwl.us.dell.com/content/topics/segtopic.aspx/dell_recycling?c=us&cs=19&l=en&s=dhs
www.crc.org
www.youthfortechnology.org/frames.html
http://earth911.org/recycling/computer-recycling-reuse/
www.epa.gov/epaoswer/hazwaste/recycle/ecycling/donate.htm
www.recycles.org/
http://wwl.pcdisposal.com/?gclid=COmh6bS75oCFRYiagodNwOFCA
www.computerhope.com/disposal.htm

EXPERIENCE BOX

Better Organization & Time Management: Dealing with the Information Deluge in College—& in Life

An Experience Box appears at the end of each chapter. Each box offers you the opportunity to acquire useful experience that directly applies to the Digital Age. This first box illustrates skills that will benefit you in college, in this course and others. (Students reading the first eight editions of our book have told us they received substantial benefit from these suggestions.)

"How on earth am I going to be able to keep up with what's required of me?" you may ask yourself. "How am I going to handle the information glut?" The answer is: *by learning how to learn.* By building your skills as a learner, you certainly help yourself do better in college, and you also train yourself to be an information manager in the future.

Using Your "Prime Study Time"

Each of us has a different energy cycle. The trick is to use it effectively. That way, your hours of best performance will coincide with your heaviest academic demands. For example, if your energy level is high during the evenings, you should plan to do your studying then.

To capitalize on your prime study time, take the following steps: (l) Make a study schedule for the entire term, and indicate the times each day during which you plan to study. (2) Find some good places to study—places where you can avoid distractions. (3) Avoid time wasters, but give yourself frequent rewards for studying, such as a TV show, a favorite piece of music, or a conversation with a friend.

Learning to Focus

Multitasking is shifting focus from one task to another in rapid succession. When you read this textbook while listening to music and watching TV, you may think you're simultaneously doing three separate tasks, but you're really not. "It's like playing tennis with three balls," says one expert.[73] Today multitasking is easy and focus is hard because of all the things demanding our attention—phone calls, email, text messages, music, radio, TV, Twitter, MySpace, Facebook, various blogs and websites. "You can drive yourself crazy trying to multitask and answer every email message instantly," says one writer. "Or you can recognize your brain's finite capacity for processing information."[74]

Here are some tips on learning to concentrate:[75]

Choose What to Focus On. "People don't realize that attention is a finite resource, like money," one expert says. "Do you want to invest your cognitive cash on endless Twittering or Net surfing or couch potatoing [watching TV]?" She adds, "Where did the idea come from that anyone who wants to contact you can do so at any time? You need to take charge of what you pay attention to instead of responding to the latest stimuli."[76] For example, to block out noise, you can wear earplugs while reading.

Devote the First l½ Hours of Your Day to Your Most Important Task. Writing a paper? Studying a hard subject? Make it your first task of the day, and concentrate on it for 90 minutes. After that, your brain will probably need a rest, and you can answer email, return phone calls, and so on. But until that first break, don't do anything else, because it can take the brain 20 minutes to refocus.

Improving Your Memory Ability

Memorizing is, of course, one of the principal requirements for succeeding in college. And it's a great help for success in life afterward. Some suggestions:

Space Your Studying, Rather than Cramming. Cramming—making a frantic, last-minute attempt to memorize massive amounts of material—is probably the least effective means of absorbing information. Research shows that it's best to space out your studying of a subject over successive days. A series of study sessions over several days is preferable to trying to do it all during the same number of hours on one day. It is *repetition* that helps move information into your long-term memory bank.

Review Information Repeatedly—Even "Overlearn" It. By repeatedly reviewing information—known as "rehearsing"—you can improve both your retention and your understanding of it. Overlearning is continuing to review material even after you appear to have absorbed it.

Use Memorizing Tricks. There are several ways to organize information so that you can retain it better. For example, you can make drawings or diagrams (as of the parts of a computer system). Some methods of establishing associations between items you want to remember are given opposite. *(● See Panel I.IO.)*

How to Improve Your Reading Ability: The SQ3R Method

SQ3R stands for "survey, question, read, recite, and review."[77] The strategy behind the method is to break down a reading assignment into small segments and master each before moving on. The five steps of the SQ3R method are as follows:

- **Mental and physical imagery:** Use your visual and other senses to construct a personal image of what you want to remember. Indeed, it helps to make the image humorous, action-filled, or outrageous in order to establish a personal connection. Example: To remember the name of the 21st president of the United States, Chester Arthur, you might visualize an author writing the number "21" on a wooden chest. This mental image helps you associate chest (Chester), author (Arthur), and 21 (21st president).
- **Acronyms and acrostics:** An acronym is a word created from the first letters of items in a list. For instance, *Roy G. Biv* helps you remember the colors of the rainbow in order: red, orange, yellow, green, blue, indigo, violet. An acrostic is a phrase or sentence created from the first letters of items on a list. For example, *Every Good Boy Does Fine* helps you remember that the order of musical notes on the treble staff is *E-G-B-D-F.*
- **Location:** Location memory occurs when you associate a concept with a place or imaginary place. For example, you could learn the parts of a computer system by imagining a walk across campus. Each building you pass could be associated with a part of the computer system.
- **Word games:** Jingles and rhymes are devices frequently used by advertisers to get people to remember their products. You may recall the spelling rule "I before E except after C or when sounded like A as in *neighbor* or *weigh*." You can also use narrative methods, such as making up a story.

panel 1.10
Some memorizing tricks

1. *Survey the chapter before you read it:* Get an overview of the chapter before you begin reading it. If you have a sense of what the material is about before you begin reading it, you can predict where it is going. In this text, we offer on the first page of every chapter a list of the main heads and accompanying key questions. At the end of each chapter we offer a Summary, which recalls what the chapter's terms and concepts mean and why they are important.
2. *Question the segment in the chapter before you read it:* This step is easy to do, and the point, again, is to get you involved in the material. After surveying the entire chapter, go to the first segment—whether a whole section, a subsection, or even just paragraph, depending on the level of difficulty and density of information. Look at the topic heading of that segment (or first sentence of a very difficult paragraph). In your mind, restate the heading as a question. In this book, to help you do this, following each section head we present a Key Question. An example in this chapter was "What are three directions of computer development and three directions of communications development?"

   After you have formulated the question, go to steps 3 and 4 (read and recite). Then proceed to the next segment of the chapter and restate the heading there as a question, and so on.
3. *Read the segment about which you asked the question:* When you read the segment you asked the question about, read with purpose, to answer the question you formulated. Underline or highlight sentences that you think are important, if they help you answer the question. Read this portion of the text more than once, if necessary, until you can answer the question. In addition, determine whether the segment covers any other significant questions, and formulate answers to these, too. After you have read the segment, proceed to step 4. (Perhaps you can see where this is all leading. If you read in terms of questions and answers, you will be better prepared when you see exam questions about the material later.)
4. *Recite the main points of the segment:* Recite means "say aloud." Thus, you should speak out loud (or softly) the answer to the principal question or questions about the segment and any other main points.
5. *Review the entire chapter by repeating questions:* After you have read the chapter, go back through it and review the main points. Then, without looking at the book, test your memory by repeating the questions and answers you formulated.

Clearly the SQ3R method takes longer than simply reading with a rapidly moving color marker or underlining pencil. However, the technique is far more effective because it requires your involvement and understanding. These are the keys to all effective learning.

Learning from Lectures

Does attending lectures really make a difference? Research shows that students with grades of B or above were more apt to have better class attendance than students with grades of C- or below.[78]

Some tips for getting the most out of lectures:

Take Effective Notes by Listening Actively. Research shows that good test performance is related to good

note taking.[79] And good note taking requires that you listen actively—that is, participate in the lecture process. Here are some ways to take good lecture notes:

- *Read ahead and anticipate the lecturer:* Try to anticipate what the instructor is going to say, based on your previous reading. Having background knowledge makes learning more efficient.
- *Listen for signal words:* Instructors use key phrases such as "The most important point is . . . ," "There are four reasons for . . . ," "The chief reason . . . ," "Of special importance . . . ," "Consequently . . ." When you hear such signal phrases, mark your notes with a ! or *.
- *Take notes in your own words:* Instead of just being a stenographer, try to restate the lecturer's thoughts in your own words, which will make you pay attention more.
- *Ask questions:* By asking questions during the lecture, you necessarily participate in it and increase your understanding.

Review Your Notes Regularly. Make it a point to review your notes regularly—perhaps on the afternoon after the lecture, or once or twice a week. We cannot emphasize enough the importance of this kind of reviewing.

SUMMARY

application software (p. 33) Software that has been developed to solve a particular problem, perform useful work on general-purpose tasks, or provide entertainment. Why it's important: *Application software such as word processing, spreadsheet, database management, graphics, and communications packages are commonly used tools for increasing people's productivity.*

avatar (p. 6) Computer depiction of a human, often found in online videogames. Why it's important: *Avatars can be helpful in training, such as by representing imaginary customers.*

case (p. 28) Also known as the *system unit* or *system cabinet;* the box that houses the processor chip (CPU), the memory chips, and the motherboard with power supply, as well as storage devices—floppy-disk drive, hard-disk drive, and CD or DVD drive. Why it's important: *The case protects many important processing and storage components.*

CD (compact-disk) drive (p. 31) Storage device that uses laser technology to read data from optical disks. Why it's important: *New software is generally supplied on CDs rather than diskettes. And even if you can get a program on floppies, you'll find it easier to install a new program from one CD than to repeatedly insert and remove many diskettes. The newest version is called DVD (digital video disk). The DVD format stores even more data than the CD format.*

central processing unit (CPU) *See* **processor chip.**

chip *See* **processor chip.**

clients (p. 24) Computers and other devices connected to a server, a central computer. Why it's important: *Client/server networks are used in many organizations for sharing databases, devices, and programs.*

cloud computing (p. 36) Concept of storing your software and/or data not on your own PC or company's computers but rather on servers on the internet. Why it's important: *Users could tap into computers as they are needed, distributing computing workload among data centers in different parts of the world, perhaps making computing cheaper and more reliable.*

communications technology (p. 4) Also called *telecommunications technology;* consists of electromagnetic devices and systems for communicating over long distances. Why it's important: *Communications systems using electronic connections have helped to expand human communication beyond face-to-face meetings.*

computer (p. 4) Programmable, multiuse machine that accepts data—raw facts and figures—and processes (manipulates) it into useful information, such as summaries and totals. Why it's important: *Computers greatly speed up problem solving and other tasks, increasing users' productivity.*

computer savvy (p. 3) Knowing what computers can do and what they can't, knowing how they can benefit you and how they can harm you, and knowing when you can solve computer problems and when you have to call for help. Why it's important: *You will know how to make better buying decisions, how to fix ordinary computer problems, how to upgrade your equipment and integrate it with new products, how to use the internet most effectively, how to protect yourself against online villains, and what kinds of computer uses can advance your career.*

connectivity (p. 35) Ability to connect computers to one another by communications lines, so as to provide online information access and/or the sharing of peripheral devices. Why it's important: *Connectivity is the foundation of the advances in the Information Age. It provides online access to countless types of information and services. The connectivity resulting from the expansion of computer networks has made possible email and online shopping, for example.*

course-management software (p. 6) Software for administering online assignments, schedules, examinations, and grades. Why it's important: *It helps to make administrative "housekeeping" more efficient.*

cyberspace (p. 18) Term used to refer to not only the online world and the internet in particular but also the whole wired and wireless world of communications in general. Why it's important: *More and more human activities take place in cyberspace.*

data (p. 25) Raw facts and figures that are processed into information. Why it's important: *Users need data to create useful information.*

desktop PC (p. 23) Microcomputer unit that sits on a desk, with the keyboard in front and the monitor often on top. Why it's important: *Desktop PCs and tower PCs are the most commonly used types of microcomputer.*

distance learning (p. 6) Also known as *e-learning;* name given to online education programs. Why it's important: *Provides students increased flexibility because they do not have to be in an actual classroom.*

download (p. 9) To transfer data from a remote computer to one's own computer. Why it's important: *Allows text, music, and images to be transferred quickly by telecommunications.*

DVD (digital video-disk) drive *See* **CD drive.**

email (electronic mail) (p. 5) Messages transmitted over a computer network, most often the internet. Why it's important: *Email has become universal; one of the first things new computer users learn is how to send and receive email.*

ethics (p. 37) Set of moral values or principles that govern the conduct of an individual or a group. Why it's important: *Ethical questions arise often in connection with information technology.*

expansion slots (p. 29) Internal "plugs" used to expand the PC's capabilities. Why it's important: *Expansion slots give you places to plug in additional circuit boards, such as those for video, sound, and communications (modem).*

hard-disk drive (p. 30) Storage device that stores billions of characters of data on a nonremovable disk platter usually inside the computer case. Why it's important: *Hard disks hold much more data than diskettes do. Nearly all microcomputers use hard disks as their principal secondary-storage medium.*

hardware (p. 25) All machinery and equipment in a computer system. Why it's important: *Hardware runs under the control of software and is useless without it. However, hardware contains the circuitry that allows processing.*

information (p. 25) Data that has been summarized or otherwise manipulated for use in decision making. Why it's important: *The whole purpose of a computer (and communications) system is to produce (and transmit) usable information.*

information technology (IT) (p. 4) Technology that helps to produce, manipulate, store, communicate, and/or disseminate information. Why it's important: *Information technology is bringing about the fusion of several important industries dealing with computers, telephones, televisions, and various handheld devices.*

input (p. 26) Whatever is put in ("input") to a computer system. Input devices include the keyboard and the mouse. Why it's important: *Useful information cannot be produced without input data.*

interactivity (p. 35) Two-way communication; a user can respond to information he or she receives and modify the process. Why it's important: *Interactive devices allow the user to actively participate in a technological process instead of just reacting to it.*

internet (the "net") (p. I8) Worldwide computer network that connects hundreds of thousands of smaller networks linking computers at academic, scientific, and commercial institutions, as well as individuals. Why it's important: *Thanks to the internet, millions of people around the world can share all types of information and services.*

keyboard (p. 28) Input device that converts letters, numbers, and other characters into electrical signals readable by the processor. Why it's important: *Keyboards are the most common kind of input device.*

local area network (LAN) (p. 22) Network that connects, usually by special cable, a group of desktop PCs and other devices, such as printers, in an office or a building. Why it's important: *LANs have replaced mainframes for many functions and are considerably less expensive.*

mainframe (p. 22) Second-largest computer available, after the supercomputer; capable of great processing speeds and data storage. Costs $5,000–$5 million. Small mainframes are often called *midsize computers.* Why it's important: *Mainframes are used by large organizations (banks, airlines, insurance companies, universities) that need to process millions of transactions.*

memory chip (p. 29) Also known as *RAM* (for "random access memory") *chip;* represents primary storage or temporary storage. Why it's important: *Holds data before processing and information after processing, before it is sent along to an output or storage device.*

microcomputer (p. 22) Also called *personal computer;* small computer that fits on or next to a desk or can be carried around. Costs $500–$5,000. Why it's important: *The microcomputer has lessened the reliance on mainframes and has provided more ordinary users with access to computers. It can be used as a stand-alone machine or connected to a network.*

microcontroller (p. 23) Also called an *embedded computer;* the smallest category of computer. Why it's important: *Microcontrollers are the tiny, specialized microprocessors built into "smart" electronic devices, such as appliances and automobiles.*

micropayments (p. 9) Electronic payments of as little as 25 cents in transactions for which it is uneconomical to use a credit card. Why it's important: *Allows products to be sold that previously weren't worth the effort of merchandising.*

mobile internet device (MID) (p. 23) Fully internet integrated, handheld computer highly compatible with desktop microcomputers and laptops. The initial models focus on data communication, not voice communication. Why it's important: *Some mobile devices are too small to adequately view images on screen, but viewers still want more pocket-size portability than is possible with a laptop.*

modem (p. 32) Device that sends and receives data over telephone lines to and from computers. Why it's important: *A modem enables users to transmit data from one computer to another by using standard telephone lines instead of special communications equipment.*

monitor (p. 3I) Display device that takes the electrical signals from the video card and forms an image using points of colored light on the screen. Why it's important: *Monitors enable users to view output without printing it out.*

motherboard (p. 29) Also called the *system board;* main circuit board in the computer. Why it's important: *This is the big green circuit board to which everything else—such as the keyboard, mouse, and printer—is attached. The processor chip and memory chips are also installed on the motherboard.*

mouse (p. 28) Nonkeyboard input device, called a "pointing device," used to manipulate objects viewed on the computer display screen. Why it's important: *For many purposes, a mouse is easier to use than a keyboard for inputting commands. Also, the mouse is used extensively in many graphics programs.*

multimedia (p. 35) From "multiple media"; technology that presents information in more than one medium—including text, graphics, animation, video, and sound—in a single integrated communication. Why it's important: *Multimedia is used increasingly in business, the professions, and education to improve the way information is communicated.*

nanotechnology (p. 22) Technology whereby molecule-size nanostructures are used to create tiny machines for holding data or performing tasks. Why it's important: *Could result in tremendous computer power in molecular-size devices.*

netbook (p. 23) Low-cost, lightweight computer with tiny dimensions and with functions designed for basic tasks, such as web searching, email, and word processing; weighs 2.25–3.2 pounds. Why it's important: *Cheaper computers that fill a technological category between notebooks and handheld devices.*

network (p. 5) Communications system connecting two or more computers. Why it's important: *Networks allow users to share applications and data and to use email. The internet is the largest network.*

notebook computer (p. 23) Also called *laptop computer;* lightweight portable computer with a built-in monitor, keyboard, hard-disk drive, battery, and adapter; weighs l.8–9 pounds. Why it's important: *Notebook and other small computers have provided users with computing capabilities in the field and on the road.*

online (p. 4) Using a computer or some other information device, connected through a network, to access information and services from another computer or information device. Why it's important: *Online communication is widely used by businesses, services, individuals, and educational institutions.*

output (p. 26) Whatever is output from ("put out of") the computer system; the results of processing. Why it's important: *People use output to help them make decisions. Without output devices, computer users would not be able to view or use the results of processing.*

peripheral device (p. 3l) Any component or piece of equipment that expands a computer's input, storage, and output capabilities. Examples include printers and disk drives. Why it's important: *Most computer input and output functions are performed by peripheral devices.*

personal digital assistant (PDA) (p. 23) Also known as *handheld computer* or *palmtop;* used as a schedule planner and address book and to prepare to-do lists and send email and faxes. Why it's important: *PDAs make it easier for people to do business and communicate while traveling.*

primary storage (p. 26) Also called *memory;* internal computer circuitry that temporarily holds data waiting to be processed. Why it's important: *By holding data, primary storage enables the processor to process.*

printer (p. 32) Output device that produces text and graphics on paper. Why it's important: *Printers provide one of the principal forms of computer output.*

processing (p. 26) The manipulation a computer does to transform data into information. Why it's important: *Processing is the essence of the computer, and the processor is the computer's "brain."*

processor chip (p. 28) Also called the *processor,* the *CPU (central processing unit),* or simply *chip;* tiny piece of silicon that contains millions of miniature electronic circuits used to process data. Why it's important: *Chips have made possible the development of small computers.*

robot (p. 7) Automatic device that performs functions ordinarily performed by human beings. Why it's important: *Robots help perform tasks that humans find difficult or impossible to do.*

secondary storage (p. 26) Also called *storage;* devices and media that store data and programs permanently—such as disks and disk drives, tape and tape drives, CDs and CD drives. Why it's important: *Without secondary storage, users would not be able to save their work. Storage also holds the computer's software.*

server (p. 24) Central computer in a network that holds collections of data (databases) and programs for connecting PCs, workstations, and other devices, which are called *clients.* Why it's important: *Servers enable many users to share equipment, programs, and data.*

software (p. 25) Also called *programs;* step-by-step electronically encoded instructions that tell the computer hardware how to perform a task. Why it's important: *Without software, hardware is useless.*

sound card (p. 3l) Special circuit board that enhances the computer's sound-generating capabilities by allowing sound to be output through speakers. Why it's important: *Sound is used in multimedia applications. Also, many users like to listen to music CDs and MP3 files on their computers.*

speakers (p. 32) Devices that play sounds transmitted as electrical signals from the sound card. Speakers are connected to a single wire plugged into the back of the computer. Why it's important: *See* **sound card.**

supercomputer (p. 2l) High-capacity computer with thousands of processors that is the fastest calculating device ever invented. Costs up to $350 million or more. Why it's important: *Supercomputers are used primarily for research purposes, airplane design, oil exploration, weather forecasting, and other activities that cannot be handled by mainframes and other less powerful machines.*

system software (p. 32) Software that helps the computer perform essential operating tasks. Why it's important: *Application software cannot run without system software. System software consists of several programs. The most important is the operating system, the master control program that runs the computer. Examples of operating system software for the PC are various Microsoft programs (such as Windows 95, 98, NT, Me, XP, and Vista), Unix, Linux, and the Macintosh operating system.*

system unit *See* **case.**

telemedicine (p. 6) Medical care delivered via telecommunications. Why it's important: *Allows physicians in remote areas to consult over a distance.*

terminal (p. 22) Input and output device that uses a keyboard for input and a monitor for output; it cannot process data. Why it's important: *Terminals are generally used to input data to and receive data from a mainframe computer system.*

tower PC (p. 23) Microcomputer unit that sits as a "tower," often on the floor, freeing up desk space. Why it's important: *Tower PCs and desktop PCs are the most commonly used types of microcomputer.*

video card (p. 31) Circuit board that converts the processor's output information into a video signal for transmission through a cable to the monitor. Why it's important: *Virtually all computer users need to be able to view video output on the monitor.*

virtual (p. 8) Something that is created, simulated, or carried on by means of a computer or a computer network. Why it's important: *Allows actual objects to be represented in computer-based form.*

workstation (p. 22) Smaller than a mainframe; expensive, powerful computer generally used for complex scientific, mathematical, and engineering calculations and for computer-aided design and computer-aided manufacturing. Why it's important: *The power of workstations is needed for specialized applications too large and complex to be handled by PCs.*

World Wide Web (the "web") (p. 18) The interconnected system of internet servers that support specially formatted documents in multimedia form—sounds, photos, and video as well as text. Why it's important: *The web is the most widely known part of the internet.*

CHAPTER REVIEW

More and more educators are favoring an approach to learning (presented by Benjamin Bloom and his colleagues in *Taxonomy of Educational Objectives)* that follows a hierarchy of six critical-thinking skills: (a) two lower-order skills—memorization and comprehension; and (b) four higher-order skills—application, analysis, synthesis, and evaluation. While you may be able to get through many introductory college courses by simply memorizing facts and comprehending the basic ideas, to advance further you will probably need to employ the four higher-order thinking skills.

In the Chapter Review at the end of each chapter, we have implemented this hierarchy in a three-stage approach, as follows:

- *Stage I learning—memorization:* "I can recognize and recall information." Self-test questions, multiple-choice questions, and true/false questions enable you to test how well you recall basic terms and concepts.
- *Stage 2 learning—comprehension:* "I can recall information in my own terms and explain it to a friend." Using open-ended short-answer questions, we ask you to reexpress terms and concepts in your own words.
- *Stage 3 learning—applying, analyzing, synthesizing, evaluating:* "I can apply what I've learned, relate these ideas to other concepts, build on other knowledge, and use all these thinking skills to form a judgment." In this part of the Chapter Review, we ask you to put the ideas into effect using the activities described, some of which include internet activities. The purpose is to help you take possession of the ideas, make them your own, and apply them realistically to your life.

stage I LEARNING — MEMORIZATION

"I can recognize and recall information."

Self-Test Questions

1. The _____ _____ _____ refers to the part of the internet that presents information in multimedia form.
2. The two main types of microcomputers are the_____ _____, which sits on the desktop, and the _____ _____, which usually is placed on the floor.
3. "_____ technology" merges computing with high-speed communications.
4. A(n) _____ is an electronic machine that accepts data and processes it into information.
5. The _____ is a worldwide network that connects hundreds of thousands of smaller networks.
6. _____ refers to information presented in nontextual forms such as video, sound, and graphics.
7. _____ are high-capacity machines with thousands of processors.
8. Embedded computers, or _____, are installed in "smart" appliances and automobiles.
9. The kind of software that enables users to perform specific tasks is called _____ software.
10. RAM is an example of _____ storage, and a hard drive is an example of _____ storage.

11. A(n) _____ is a communications system connecting two or more computers.
12. The four basic operations of all computers are _____, _____, _____, and _____.
13. The first programmable computer in the USA, which appeared in 1946, was called the _____.
14. The _____ is the display device that takes the electrical signals from the video card and forms an image using points of colored light on the screen.
15. The base material for computer processing devices is _____, a natural element found in sand.
16. The general term for all the machinery and equipment in a computer system is _____.
17. _____ and _____ are the two most common input devices.
18. The processor chip, commonly called the _____ or a _____, is a tiny piece of silicon that contains millions of miniature electronic circuits.
19. One gigabyte is approximately _____ characters.

Multiple-Choice Questions

1. Which of the following devices converts computer output into displayed images?
   a. printer
   b. monitor
   c. floppy-disk drive
   d. processor
   e. hard-disk drive
2. Which of the following computer types is the smallest?
   a. mainframe
   b. microcomputer
   c. microcontroller
   d. supercomputer
   e. workstation
3. Which of the following is a secondary-storage device?
   a. processor
   b. memory chip
   c. floppy-disk drive
   d. printer
   e. monitor
4. Since the days when computers were first made available, computers have developed in three directions. What are they?
   a. increased expense
   b. miniaturization
   c. increased size
   d. affordability
   e. increased speed
5. Which of the following operations constitute the four basic operations followed by all computers?
   a. input
   b. storage
   c. programming
   d. output
   e. processing
6. Supercomputers are used for
   a. breaking codes.
   b. simulations for explosions of nuclear bombs.
   c. forecasting weather.
   d. keeping planets in orbit.
   e. all of these
   f. only a, b, and c.
7. What is the leading use of computers?
   a. web surfing
   b. email
   c. e-shopping
   d. word processing
8. Which is the main circuit board in the computer?
   a. RAM chip (random access memory)
   b. CPU processor chip (central processing unit)
   c. motherboard (system board)
   d. hard drive
9. A terabyte is approximately
   a. one million characters.
   b. one billion characters.
   c. one trillion characters.
   d. one quadrillion characters.
10. Speakers are an example of
    a. an input device.
    b. an output device.
    c. a processor.
    d. a storage device.

True/False Questions

T F 1. Mainframe computers process faster than microcomputers.
T F 2. Main memory is a software component.
T F 3. The operating system is part of the system software.
T F 4. Processing is the manipulation by which a computer transforms data into information.
T F 5. Primary storage is the area in the computer where data or information is held permanently.
T F 6. The keyboard and the mouse are examples of input devices.
T F 7. Movies are a form of multimedia.
T F 8. Computers are becoming larger, slower, and more expensive.
T F 9. Modems store information.
T F 10. A microcomputer is used to view very small objects.
T F 11. A hard disk is an example of software.
T F 12. Computers continue to get smaller and smaller.
T F 13. Supercomputers are particularly inexpensive.

Stage 2 LEARNING COMPREHENSION

"I can recall information in my own terms and explain it to a friend."

Short-Answer Questions

1. What does *online* mean?
2. What is the difference between system software and application software?
3. Briefly define *cyberspace.*
4. What is the difference between software and hardware?
5. What is a local area network?
6. What is multimedia?
7. What is the difference between microcomputers and supercomputers?
8. What is the function of RAM?
9. What does *downloading* mean?
10. What is meant by *connectivity?*
11. Describe some ways that information technology can be used to help people find jobs and to help jobs find people.
12. Compare the use of email to the use of the telephone and of conventional letters sent via the postal system. Which kinds of communications are best suited for which medium?
13. What is the basic meaning of *cloud computing?*

Stage 3 LEARNING APPLYING, ANALYZING, SYNTHESIZING, EVALUATING

"I can apply what I've learned, relate these ideas to other concepts, build on other knowledge, and use all these thinking skills to form a judgment."

Knowledge in Action

1. Do you wish there was an invention to make your life easier or better? Describe it. What would it do for you? Come up with ideas on how that device may be constructed.
2. Determine what types of computers are being used where you work or go to school. In which departments are the different types of computer used? Make a list of the input devices, output devices, and storage devices. What are they used for? How are they connected to other computers?
3. Imagine a business you could start or run at home. What type of business is it? What type(s) of computer(s) do you think you'll need? Describe the computer system in as much detail as possible, including hardware components in the areas we have discussed so far. Keep your notes, and then refine your answers after you have completed the course.
4. Has reality become science fiction? Or has science fiction become science fact? First, watch an old futuristic movie, such as *2001—A Space Odyssey,* and take note of the then-futuristic technology displayed. Classify what you see according to input, output, processing, storage, and communications. Then watch a recent science fiction movie, and also list all the futuristic technology used according to the given categories. What was futuristic in the old movie that is now reality? What in the new movie is not yet reality but seems already feasible?
5. From what you've read and what you have experienced and/or observed in your life, do you have a positive, negative, or impartial view of our rapidly converging technological society? Why? Reevaluate your answers at the end of the course.
6. Computer prices are constantly falling. Whatever you pay for a computer today, you can be certain that you will be able to buy a more powerful computer for less money a year from now, and quite possibly even just a month from now. So how can you decide when it's a good time to upgrade to a better computer? Paradoxically, it seems that no matter how you time it, you'll always lose, because prices will go down again soon, and yet you will also always gain, because, since you were going to upgrade sooner or later anyway, you will reap the benefits of having the more powerful equipment that much longer.

   Discuss the benefits and costs, both material and psychological, of "waiting until prices drop." Gather more information on this topic by asking friends and colleagues what choices they have made about upgrading equipment over the years and whether they feel satisfaction or regret about the timing when they finally did upgrade.
7. Computers are almost everywhere, and they affect most walks of life—business, education, government, the military, hobbies, shopping, research, and so on. What aspects of your life can you think of that still seem relatively unaffected by computers and technology? Is this a good thing or a bad thing, and is it likely to last? What aspects of your life have been the most conspicuously affected by technology? Has anything been made worse or harder in your life by the advance of computers? What about things that have been made better or easier?

8. Have you become extremely dependent on some technologies? Some people no longer write down telephone numbers anywhere; instead, they simply program them into their cellphones. Some people feel helpless in a foreign country unless they have a calculator in hand to compute currency conversions. Many people rely on their email archive to hold essential information, such as addresses and appointments. When any of these technologies fails us, we can feel lost.

   Make a list of technologies that have become indispensable to your life. Imagine the consequences if any of these technologies should fail you. What can you do to protect yourself against such failure?

9. It has been said that the computer is a "meta medium" because it can simulate (behave as) any other medium. Thus a computer can present text that can be read from virtual "pages" as if it were a book; it can let you compose and print text as if it were a typewriter; it can play music as if it were a boombox; it can display video as if it were a television set; it can make telephone calls as if it were a telephone; it can let you "draw" and "paint"; it can be programmed to serve as an answering machine; and so forth.

   Imagine a future in which computers have replaced all the things they can emulate: instead of books and magazines and newspapers, we would have text only on computers. Telephones, PDAs, television sets, VCRs, DVD players, stereo sets, and other electronic devices would all be gone or, rather, subsumed by computers. What benefits to your life can you see in such a future? What things might be worse? What dangers can you see? Do you think this kind of radical convergence is likely? If so, how long do you think it will take?

Web Exercises

If you are not yet familiar with web surfing, wait until you have finished Chapter 2 to do the following web exercises.

I. Are computers, cellphones, and other electronic devices bad for our health? You may have heard the term *electromagnetic radiation* and dismissed it as an obscure scientific term not worth understanding. Visit the links below to become educated on a topic that will be discussed more seriously and frequently when our society becomes completely wireless.

   www.howstuffworks.com/cell-phone-radiation.htm

   www.fda.gov/cellphones/

   www.consumeraffairs.com/news04/2008/03/cells_danger.html

   http://skeptoid.com/episodes/4117

2. List some pros and cons of a "paperless" environment. Do you believe that a paperless environment is something worth striving for in the workplace? In the home? In the classroom? In banking? Run a web search to see what others are doing to implement this idea.

3. Computer pioneer John Von Neumann was one of a group of individuals who conceived the idea of the "stored program." He could also divide two 8-digit numbers in his head. Spend a few hours researching this remarkable man; at online bookstores, look up some of the books he wrote and read the reviews.

4. Looking for legally free programs? Some great places to start:

   www.download.com

   www.shareware.com

   www.freewarefiles.com/

   www.freedownloadscenter.com/

5. Visit the following websites to become aware of some topics of interest in the computing world. Full comprehension of these topics isn't necessary at this time; this is only to familiarize you with subject matter you may come in contact with.

   www.zdnet.com/eweek

   www.computeruser.com/

   www.computermarket.com/news

   http://slashdot.org

6. "Moore's Law" predicts the rate at which computers will continue to get smaller (and hence faster). The "law" has proved to be astonishingly accurate over many years. Do a web search for Moore's Law, and see if you can find answers to the following questions:

   a. Who is Moore, and when did he make the prediction we know as Moore's Law?
   b. What is the simplest statement of the law's prediction?
   c. How has the law changed over time?
   d. How much longer is the law expected to hold true?
   e. How does the law affect business projections?

7. A Wiki is a website on which authoring and editing can be done very easily by anyone, anywhere, anytime using a web browser such as Internet Explorer or Netscape Navigator, with no need for special software or other special requirements. (*Wiki* is Hawaiian for "quick.") Most web pages are less than perfect. If it is a Wiki-page and you are annoyed by something, you can just hit the Edit button and change it! Over time, the site gets better (people hope)!

   Here are some examples of Wikis that deal with general knowledge:

   http://en.wikipedia.org

   www.wikimedia.org/

   http://wiki.ehow.com/Main-Page

   And here are some specialized Wikis:

   www.rawfoodwiki.org/index.php/Encyclopedia

   http://london-crafts.org/

   www.payrollwiki.com

   www.wikia.com/wiki/Wikia

   http://wikisineducation.wetpaint.com/

   a. Make a small change on a page on one of the listed sites or on some other Wiki site you have identified. Submit your change, and note the results. Anyone navigating to that site will now see your change. Did you know that website authoring could be that easy? Are you surprised that someone would unconditionally open up his or her website for anyone to edit?

b. Since you can make any change you wish, even something totally nonsensical or simply wrong, it's obviously possible for incorrect or misleading content to appear on a Wiki. Given that, why do you think that Wikis have become so popular and so widespread?

c. How significant a problem do you think vandalism and other acts of poor citizenship might be on "open" Wikis? How can you find out?

d. Some Wikis contend with the threat of vandalism by requiring that a password be provided before a user is allowed to make changes. What advantages can you see to this approach? What disadvantages? Do you think the advantages of password protection outweigh the disadvantages? What do the Wikis you browse through have to say about this issue?

e. What measures do you think an online shared space can take to limit the potential damage from vandalism, while not being overly restrictive?

f. If you knew that a particular person was defacing a Wiki, what would you do about it? Report the person? Wait for the vandal to get bored and turn his or her mischief elsewhere? Or try to reform the person? Are the basic ethical considerations here the same as those regarding other forms of vandalism in our society?

g. Do you think that open-access systems such as unrestricted Wikis will become more common over time, or do you think that abuse of such systems will destroy their usefulness and that Wikis will eventually disappear?