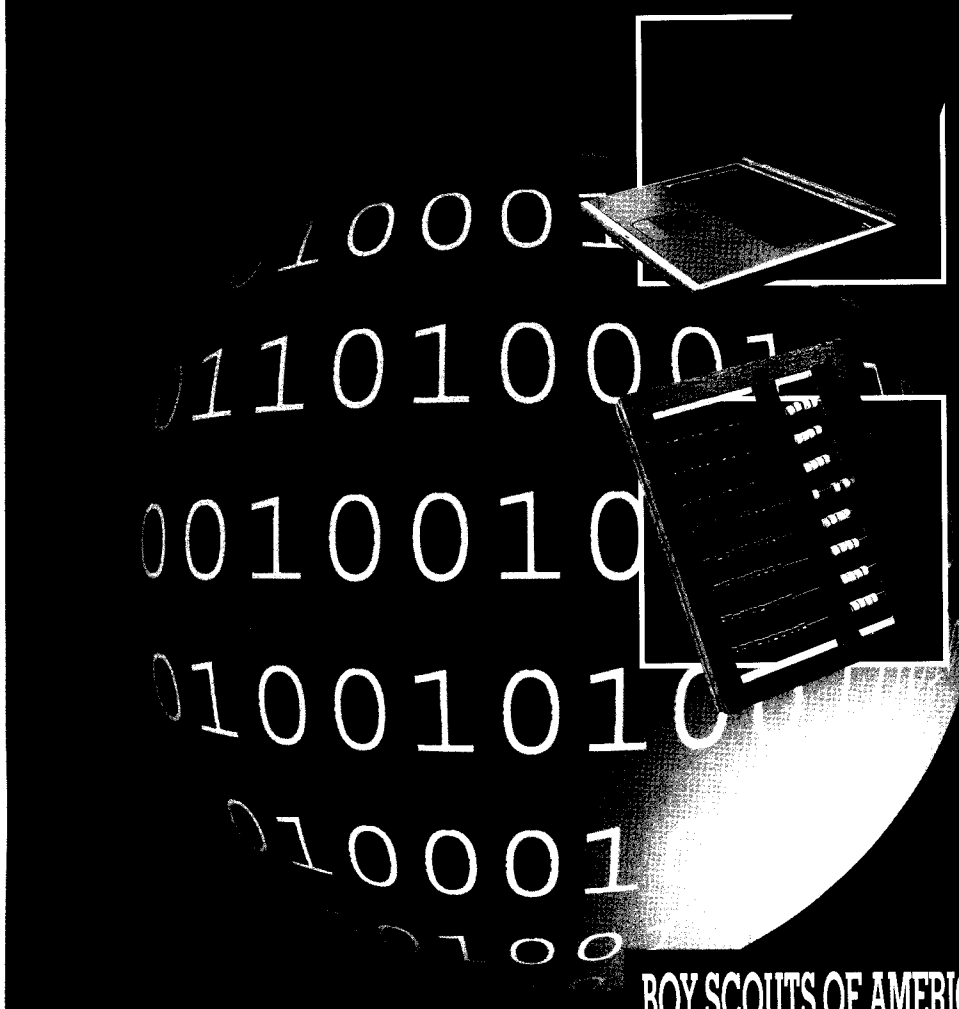
COMPUTERS



BOY SCOUTS OF AMERICA

MERIT BADGE SERIES

COMPUTERS

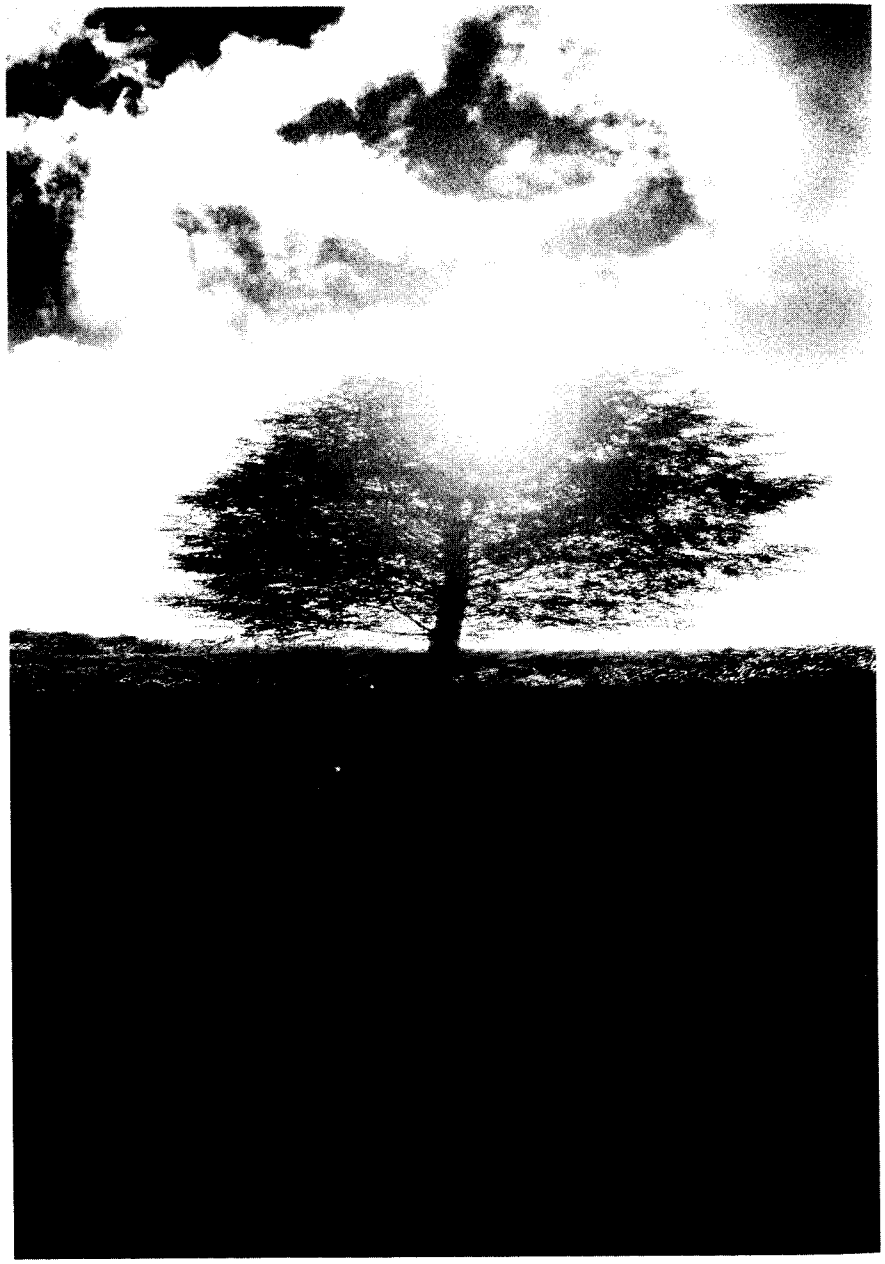
Merit Badge Requirements

Requirements were REWRITTEN effective January 1, 2006.

1. Discuss with your counselor the tips for online safety.
2. Explain how the invention of the computer has affected society, science, and technology. In your explanation, give a short history of the computer.
3. Do the following:
    A. Explain four different uses of computers.
    B. Describe three ways you and your family could use a personal computer other than for games and recreation.
4. Explain to your counselor the following:
    A. The major parts of a computer system
    B. How the types of files used to store text, sound, pictures, and video are stored in a computer's memory
5. Do the following:
    A. Explain what a program is and how it is developed.
    B. Give three examples of programming languages, and describe their uses.
    C. Name four software packages you or your family could use, and explain how you would use them.
    D. Discuss ways you can help protect a computer from viruses and how to keep secure information that has been saved on a computer.
    E. Describe how computers are linked to form the Internet and the World Wide Web.
6. Do THREE of the following:
    A. Use a database manager to create a troop roster that includes the name, rank, patrol, and telephone number of each Scout. Show your counselor that you can sort the register by each of the following categories: rank, patrol, and alphabetically by name.
    B. Use a spreadsheet program to develop a food budget for a patrol weekend campout.
    C. Use a word processor to write a letter to the parents of your troop's Scouts inviting them to a court of honor. Use the program's mail merge feature to make a personalized copy of the letter for each family.
    D. Use a computer graphics program to design and draw a campsite plan for your troop, OR design a flyer for an upcoming troop event.
    E. Using a software package of your choice, develop a short presentation about a topic that has been approved by your counselor. For your presentation create at least 10 slides.
    F. Using an Internet search engine, find ideas about how to conduct a troop court of honor or campfire program. Print out a copy of the ideas from at least three different Web sites. Share what you found with your counselor, and explain how you used the search engine to find this information.
    G. Using a digital camera, take a picture of a troop activity. Transfer the picture file to a computer and use photographic software to make it small enough to send easily as an e-mail attachment. Then, using a computer connected to the Internet (with your parent's permission), send an e-mail to someone you know. In your message, include the photograph as an attachment. Verify that the person received your e-mail and was able to view the attachment.
    H. Describe two computer chip-based devices, and explain how they are "smarter" because of the chip and its program.

I.

7. Do ONE of the following:
    A. Visit a business or an industrial plant that uses computers. Observe what tasks the computers accomplish, and be prepared to discuss what you have learned.
    B. Using a software package of your choice for computer aided design (CAD), create an engineering-style drawing of a simple object. Include the top, bottom, and at least one side view and the dimensions.
    C. Use a general purpose programming language to write a simple program application of your choice, subject to approval by your counselor.
    D. Design a Web page for your troop, patrol, school, or place of worship. You need not post the page to a Web site. However, if you decide to do so, you will first need to get your parent's permission and your counselor's approval, as well as permission from the host site.
8. For each of the following categories, discuss several related terms: input and output devices, storage media, memory, processors and coprocessors, modems or network cards, networks, World Wide Web and Internet, electronic mail, Wi-Fi.
9. Explain the following to your counselor:
    A. Why it is not permissible to accept a free copy of a copyrighted computer game or program from a friend
    B. The restrictions and limitations of downloading music from the Internet
    C. Why copyright laws exist
10. Pick two career opportunities in the computer field that interest you. Find out what education, training, and experience those positions require. Report what you learn to your counselor.



Computers in Modern Life

Simply put, *computers* are machines that perform math—adding, subtracting, multiplying, and dividing. They can perform simple calculations exceedingly fast, allowing them to operate robots that build cars, command monitors and printers to display and print words, generate fast-moving video games, and send e-mail messages around the world.

At the heart of every modern computer is the *transistor,* an electronic switch with two positions: *on* and *off.* These two positions also can be called *yes* and *no,* or *true* and *false.* To perform any task, a computer breaks down the job into a series of yes or no questions, such as, "Is someone pushing the 'S' key on the keyboard?" If the answer is yes, the computer will send a message to display an S on the computer monitor. If the answer is no, then no action is taken.

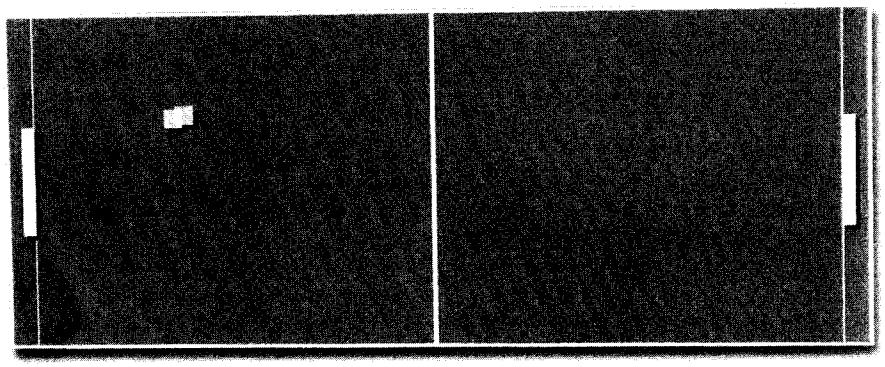
Software engineers write sets of instructions for computers called *programs,* which accomplish complex tasks by performing the computer's simple yes-or-no logic millions of times per second. Even though a computer may seem to be thinking, it is actually only doing what a person programmed it to do—very quickly.

Computers have no intelligence of their own, but some experts believe this might change in the distant future.

Computers Are Everywhere

In the modern world, computers are found almost anywhere there are machines or electronic gadgets. Often you can't even see the computer because it is smaller than your fingertip and hidden. Tiny computer processors are built into mobile phones, garage door openers, DVD players, thermostats, *digital* bathroom scales, answering machines, digital cameras, remote controls, clock radios, coffeemakers, wristwatches, vehicles, and portable radios.

Computers are common in the entertainment industry. One person using a synthesizer can make music that sounds like a whole orchestra playing. Computers help animators create special effects in movies, like making superheroes appear to jump from building to building. Computers also drive video games, a business now almost as big as the movie industry.



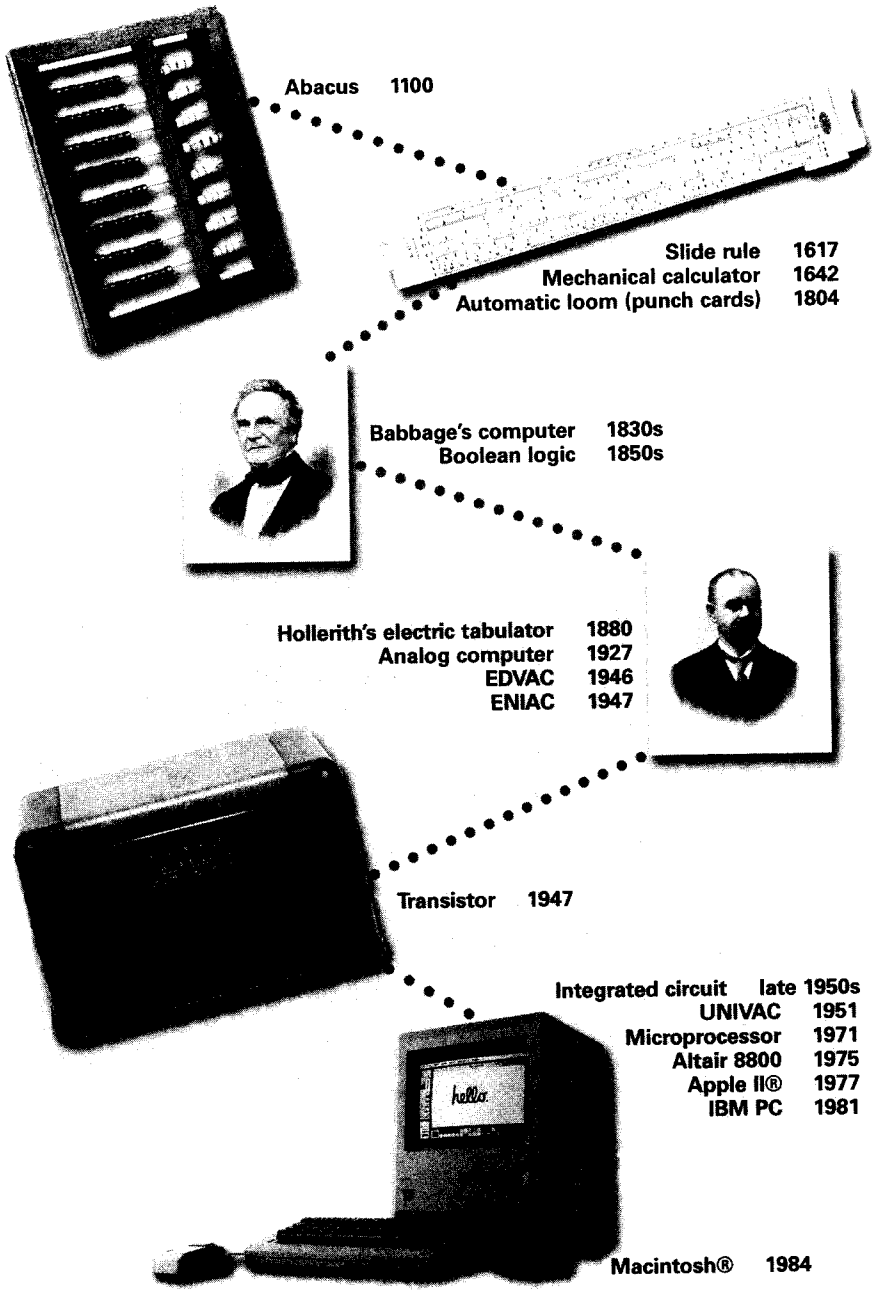
Video games have come a long way since "Pong," an early video game of the 1970s that consisted of simple white blips moving on the screen.

Computers are essential to business, industry, science, medicine, communications—practically every part of society. By using credit and debit cards embedded with information a sales-register computer can read, shoppers buy goods and services without handling cash. The register can even alert the manager to reorder when stocks of an item are getting low.

The worldwide network of computers known as the *Internet* has revolutionized communications. Now, instead of waiting days or even weeks to receive a letter through the postal mail, computer users can type an electronic letter, or *e-mail*, that zips around the world in seconds. Vast databases of information are available on the *World Wide Web*, allowing students and scientists to research direct from their home or office. And people now shop online for items from books to cars.

Computers save time and automate tedious tasks, allowing people to devote more energy to creativity, judgment, and analysis—human qualities that likely will push computer technology even further in the future.

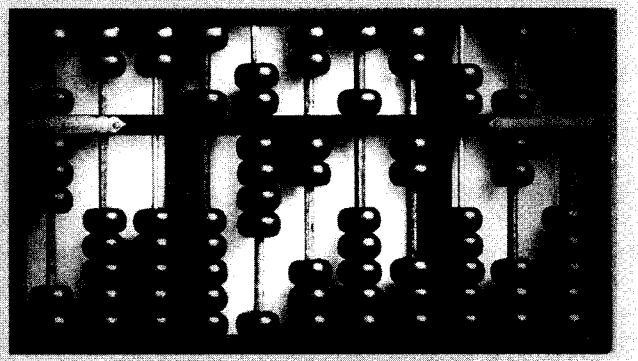
Handheld global positioning systems use computer and satellite technology to tell hikers or drivers where they are on a map.



The history of computers

History of Computers

No one person invented the modern computer; it reflects the accumulated ingenuity of inventors, mathematicians, and philosophers over the centuries. The computer's roots can be traced to simple mathematics.

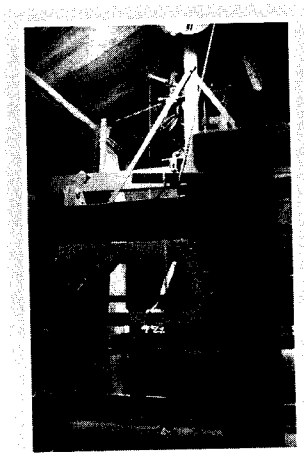


Today, we use handheld electronic calculators at home and school. But another calculating aid, the *abacus,* has been around since about 1100 B.C. and is still used in some parts of the world. It consists of a wooden frame with beads that slide along rods. By assigning a value to the beads and sliding them up and down the rods, users can add, subtract, multiply, and divide.

Like the abacus, the slide rule was only an aid to calculation, not a true calculator.

In 1617, Scottish mathematician **John Napier** invented the concept of logarithms to help simplify multiplying and dividing into a form of addition and subtraction. Not long afterward, an English clergyman named **William Oughtred** invented the slide rule based on Napier's logarithms. For the next 350 years, the slide rule was the primary mathematics tool.

In 1642, French mathematician **Blaise Pascal** invented the first practical mechanical calculator, which worked with wheels and gears. Pascal's father, a tax collector, used the machine to add up how much money people owed the government.



The First Programs

In 1804, French weaver **Joseph-Marie Jacquard** invented an automatic loom, or weaving machine, controlled by sets of instructions coded into *punched cards*. The idea of using coded instructions readable by a machine became the basis of modern computer programs.

The First Computer

In the 1830s, English mathematician **Charles Babbage** conceived plans for an analytical engine, intended to produce mathematical tables for navigation at sea. His invention comprised four main parts, all found on the computers of today:

- An *input device* to read instructions from punched cards
- A *memory* to store the instructions and results
- A *processor,* which Babbage called a *mill*
- An *output device* to print the tables of numbers

Babbage's analytical engine was designed to be programmed to perform different tasks, also like the modern computer, although his engine was mechanical and powered by steam, not electricity.

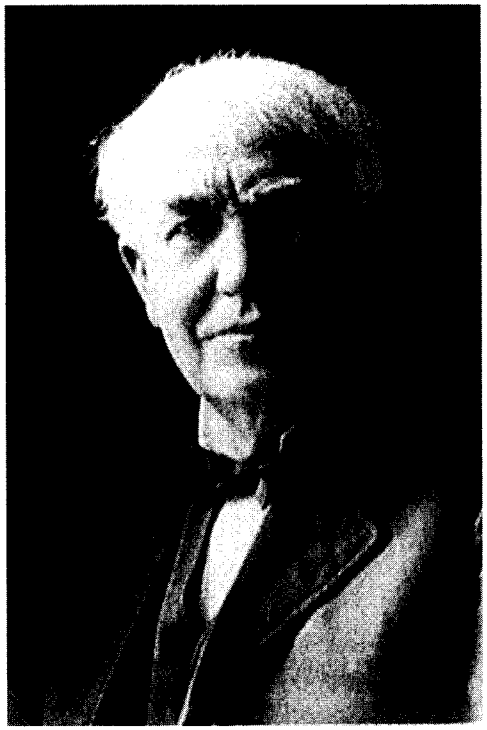
Augusta Ada King, a young woman who wrote a program for the analytical engine, is considered to be the world's first computer programmer.

Boolean Logic

In the 1840s and 1850s, English mathematician and philosopher George Boole developed a kind of logic that allows thoughts to be expressed in mathlike terms. The basic forms of Boolean logic (also called Boolean algebra) are the AND, OR, and NOT operations.

- **An AND operation is one in which two or more conditions must be true to achieve a result. For example, before you can safely cross a street intersection, the walk sign must be lit AND cross traffic must be stopped.**
- **In an OR operation, the result will happen if *either* condition is met: If it is cold outside OR if it is raining, you will put on a jacket before leaving the house.**
- **With a NOT operation, a result happens when a particular condition is *not* met: You will go to school if today does NOT fall on the weekend.**

Years after Boole died, computer designers arranged electric switches to perform these operations in what became known as logic circuits, allowing digital computers to mimic human thought processes. Later still, Boolean logic would be used in Internet search engines.

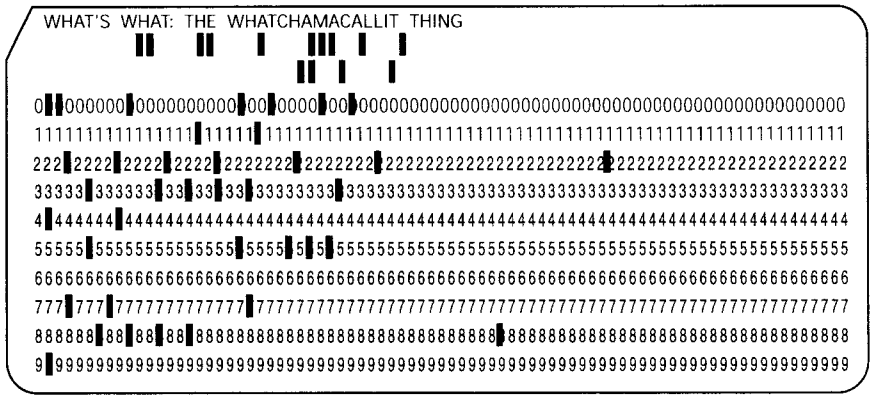


Thomas Edison

Beginnings of the Digital Age

In 1883, a few years after **Thomas Edison** invented the electric light bulb, he noticed something peculiar about how electricity flowed inside it. To protect the brightly glowing filament, air had been removed from the bulb, creating a vacuum tube. Surprisingly, if he placed a metal plate inside the bulb, electricity would flow across the vacuum from the filament to the plate.

In 1906, American **Lee de Forest** discovered that placing three electrodes inside the bulb created an amplifier—a phenomenon that would make radio and television possible. The vacuum tube also could serve as an extremely rapid on-off switch, which would prove crucial in the development of digital computers.



Punched card

Special-Purpose Calculators

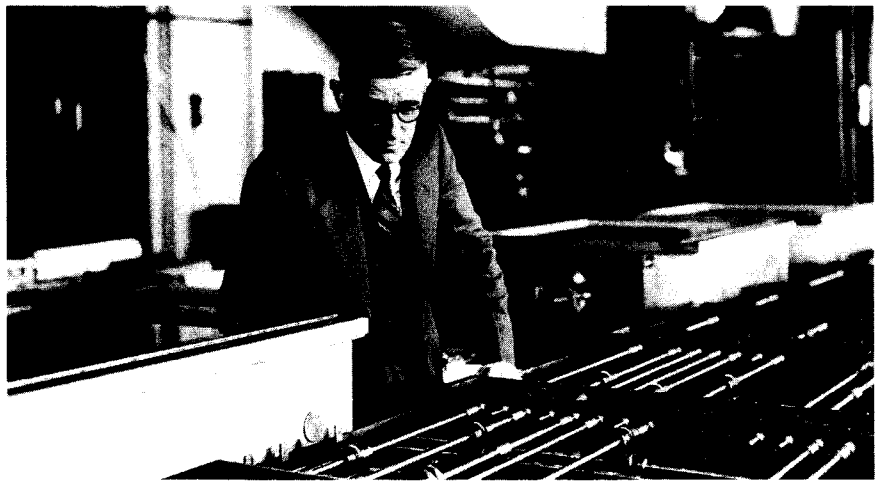
When the population of the United States grew to more than 49 million people in 1880, the government turned to American inventor **Herman Hollerith** to simplify its census—an effort to collect information about everyone who lives in the country. Hollerith's electric tabulating machine automatically tabulated punched cards prepared for each person in the country. The cards held information that could be presented in different ways—for example, to find out how many married people lived in Tennessee, or how many owned farms smaller than 3 acres. This machine was the beginning of automated data processing.

Soon, other companies began to build *special-purpose calculating machines* to help businesses, scientists, and the military. These machines were one of a kind, and each had its peculiarities.

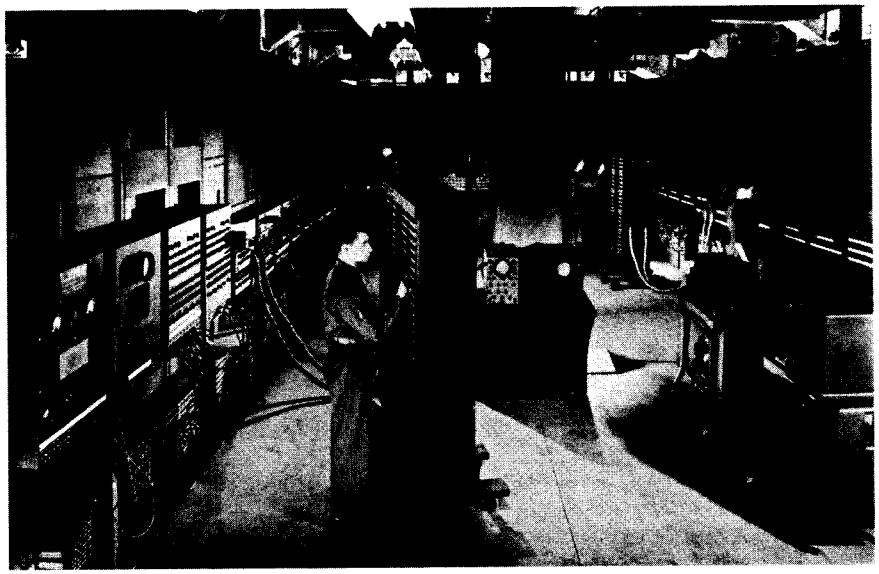
At Harvard University, professor **Howard Aiken** and **Grace Hopper** created the MARK I, using electromagnetic *relays* as switches. At the University of Pennsylvania, **John William Mauchly** and **J. Presper Eckert Jr.** designed the

The father of automated data processing, Herman Hollerith formed a company that would later become the giant IBM corporation.

Grace Hopper coined the term "bug" for a computer fault. The original bug was a moth that created a hardware problem in the MARK I. Hopper was the first person to "debug" a computer.



In 1927 at the Massachusetts Institute of Technology, engineer *Vannevar Bush* invented the differential analyzer, an electromechanical analog computer.

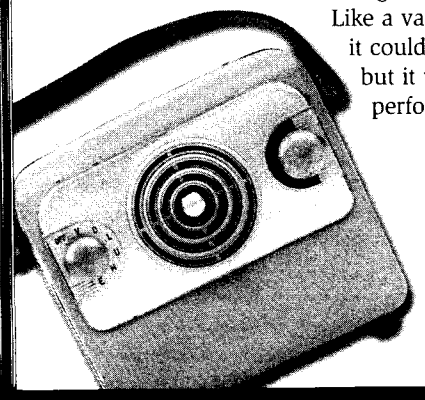


The U.S. military used first-generation digital computers like this ENIAC to calculate trajectories of artillery shells and to help build weapons.

ENIAC and EDVAC the using vacuum tubes as switches, which worked a thousand times faster than the relays in the MARK I. Each of these computers weighed tons, filled an entire room, and consumed enough electricity to light up a small town. They required thousands of vacuum tubes, partly because they tended to overheat quickly and burn out.

The Transistor

In 1947, engineers **John Bardeen, Walter Brattain,** and **William Shockley** at Bell Laboratories ushered in the second generation of computers by inventing the transistor. Like a vacuum tube, the transistor had three terminals—it could function as both an amplifier and a switch—but it was much smaller, used far less power, and performed thousands of times faster. It was made of a solid material known as a *semiconductor,* which moves electricity more slowly than a conductor and does not get hot like vacuum tubes.



Early transistors were sold to business, industry, and academia and were used in consumer products, notably the portable transistor radio.

Silicon is the most widely used semiconductor material.

The Universal Computer

The first commercially built computer, Mauchly and Eckert's UNIVAC, came into production in 1951. It was designed to be a general-purpose, or universal, computer that would serve scientists, businessmen, and engineers alike.

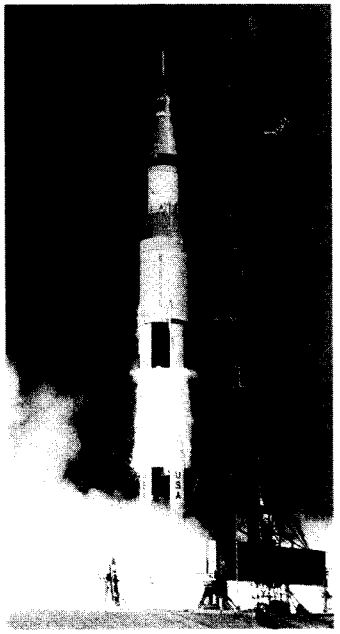
The UNIVAC was a stored-program computer, meaning the program didn't have to be fed into the computer while it was running. It also took input from data on magnetic tape, rather than punched cards, making it faster and easier to operate. Customers for the million-dollar computer included the U.S. Census Bureau, the U.S. Air Force, and commercial insurance companies.

The Integrated Circuit

A major limitation of transistors was that they had to be connected to other electronic components (resistors, capacitors, and diodes) to form circuits. An early computer may have had tens of thousands of transistors and other components that required tens of thousands of hand-soldered connections.

This problem was solved in the late 1950s when **Jack Kilby** of Texas Instruments and, a few months later, **Robert Noyce** of Fairchild Semiconductor created the *integrated circuit,* or microchip. The concept was simple: Instead of connecting numerous circuit components, manufacture them all on the same silicon *chip*—with connections built in.

Integrated circuits made possible products like the handheld calculator and digital wrist-



The Apollo space program of the 1960s, with a mission to put an American on the moon by the end of the decade, was an early user of integrated circuits.

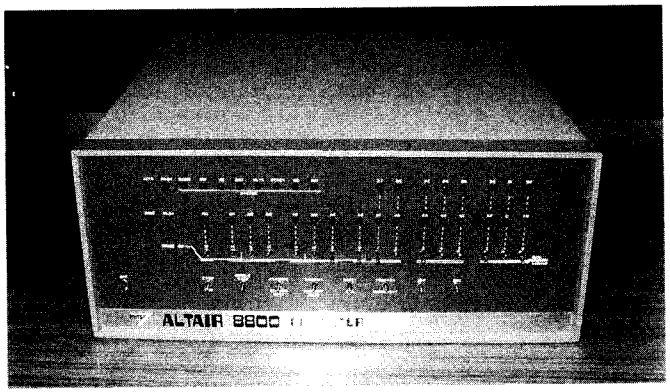
watch. They also were used in minicomputers, which, though smaller than the big mainframes of the day, still cost tens of thousands of dollars each.

The Microprocessor

In 1971, engineers at Intel Corporation advanced the integrated circuit by putting all the circuits needed for a computer's *central processing unit* (its "brain," which ran coded instructions) onto a single chip known as a *microprocessor.* This invention made it affordable for individuals—not just big business and government—to own computers.

Personal Computers

The Altair 8800 was an early model *personal computer* sold in 1975 as a mail-order kit for hobbyists to build themselves. That year, boyhood chums **Bill Gates** and **Paul Allen,** along with **Monte Davidoff,** wrote a programming language called BASIC that would run on the Altair. For a fee, they licensed the program to the computer maker and formed their own company, Microsoft®.



The Altair 8800

Meanwhile, two other young friends, **Steve Wozniak** and **Steve Jobs,** were busy working on the Apple II, a personal computer released in 1977 by their new company, Apple. Unlike most computers, the Apple II had color graphics, making it a good platform for games, and it became extremely popular with home users.

In 1979, **Daniel Bricklin** and **Robert Frankston** created a software program for the Apple II called VisiCalc, short for "visible calculator," which automatically calculated rows and columns of numbers in *spreadsheet* format. This program helped introduce personal computers into the workplace.

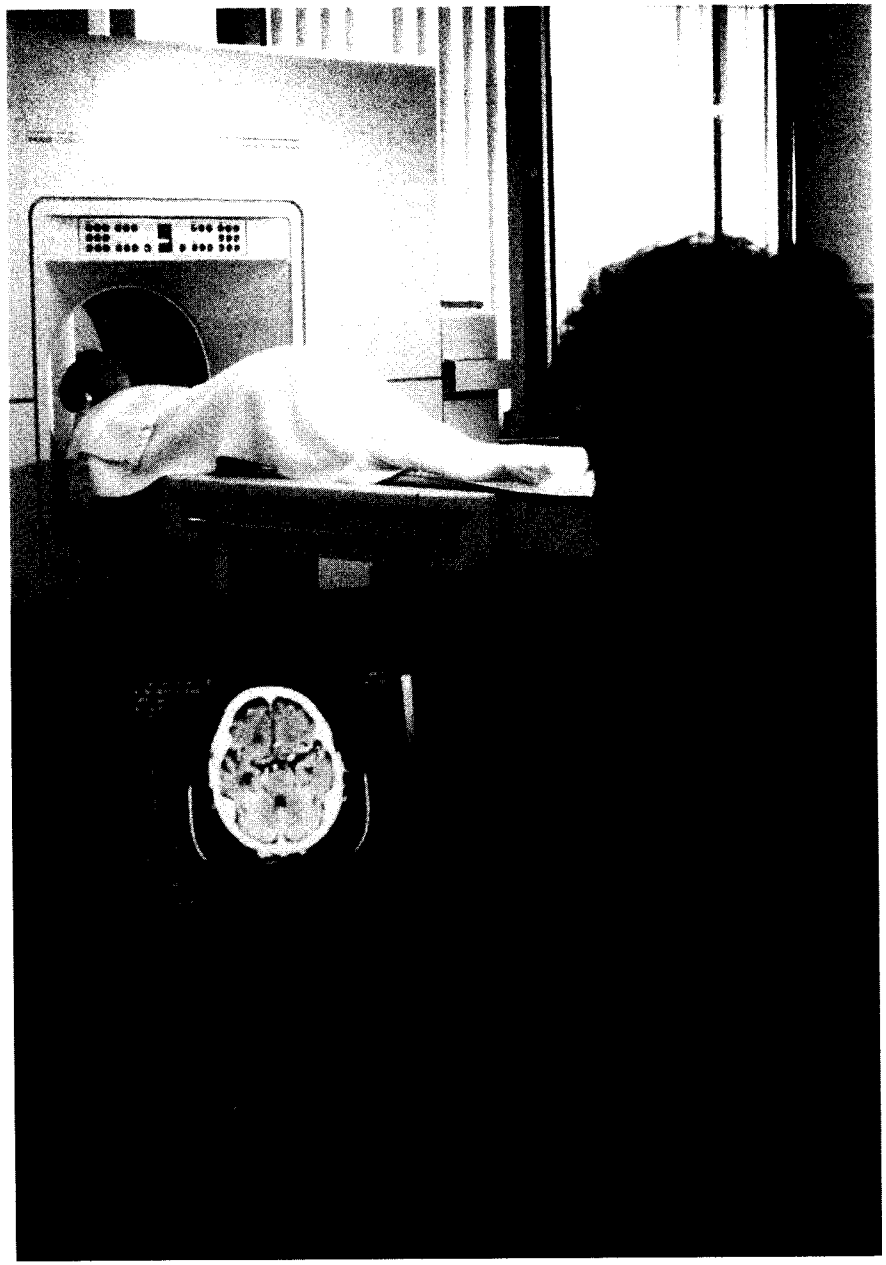
Two years later, IBM introduced its own personal computer, which ran a spreadsheet calculator and other programs, including a word processor. IBM contracted with Bill Gates and Microsoft® to supply its new PC with a form of BASIC and an *operating system*—the program that starts up the computer and interacts with application programs.

Microsoft® later created a similar operating system, MS-DOS®, for use on computers made by many different companies. The IBM PC and other computers using the MS-DOS® platform would dominate the business and home computer markets, helping make Microsoft® one of the world's largest corporations.

Apple's Macintosh® computer also had an important impact on the industry. Introduced in 1984, the Mac's operating system featured a number of innovations that made computers easier to use, many of which had been developed years earlier by researchers working for Xerox. These included a handheld pointing device, or *mouse,* the use of little pictures called *icons* to represent programs and files on the computer screen, and a system of pull-down menus and movable screen displays called windows. By 1990, Microsoft® managed to incorporate many of the user-friendly advantages of the Macintosh® into the latest version of its Windows® operating system.

Throughout the 1990s, computers continued to grow in power and drop in price. In 1971, a microprocessor held 2,250 transistors; by 1993, it was 3.1 million; by 2000, the number of transistors crammed onto one microchip topped 42 million. The original IBM PC cost $3,000 in 1981—the equivalent of more than $6,500 today, when a consumer can purchase a desktop PC many times more powerful than the original PC for less than $600.

As computer hardware improves, so does computer software. New software programs are continually introduced to take advantage of the increased power and to expand the ways in which we use computers.



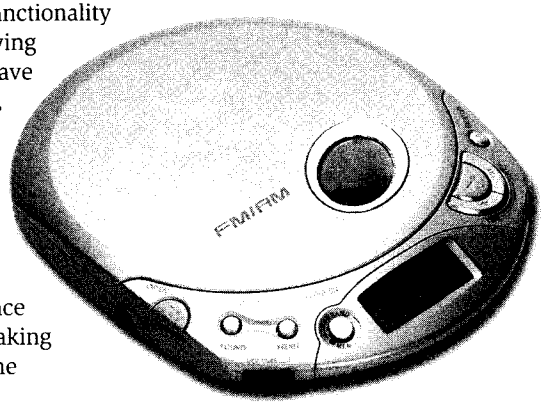
Types of Computers

There are two basic categories of computers, *special purpose* and *general purpose.*

Special-Purpose Computers

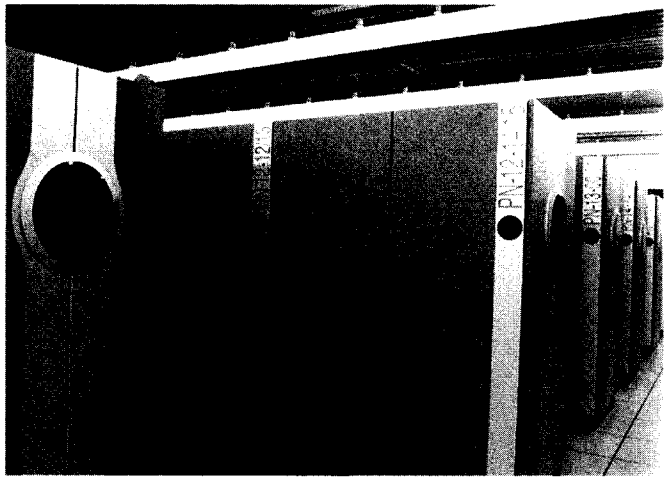
Special-purpose computers are preprogrammed to perform specific tasks, like run video games, operate antilock brakes in an automobile, keep time in a digital watch, and program a digital music player.

Often placed inside a larger device, special-purpose computers can improve functionality in items like cameras, sewing machines, clocks, microwave ovens, washing machines, DVD players, and credit cards. As embedded computers become cheap enough to be considered disposable, these tiny computers are being used to add a level of intelligence to a product or device, making it possible to customize the device's functions.



General-Purpose Computers

General-purpose computers, on the other hand, can be programmed to perform a wide range of tasks. They come in five basic sizes: *supercomputer, mainframe, minicomputer, workstation,* and *microcomputer.*



Japan's Earth Simulator

Supercomputers

Supercomputers are the largest, most expensive, and fastest computers available. They typically are used for specialized tasks involving complex calculations such as weather forecasting, military weapons simulations, and plotting the motions of galaxies. The world's fastest supercomputer is the Earth Simulator, built in Japan in 2002 and capable of sustaining almost 36 trillion calculations per second. It occupies a room 215 feet long and 165 feet wide.

Mainframes and Minicomputers

Mainframe computers are large, expensive, centrally located computers often used by hundreds or even thousands of people at once. Minicomputers are smaller than mainframes and are sometimes used in medium-sized companies to run their manufacturing plants or to keep track of inventories. They operate as small mainframes, with multiple users.

Workstations

Workstations are powerful desktop computers used by engineers, scientists, graphic artists, moviemakers, and other professionals who need to run special software requiring high-speed processors.

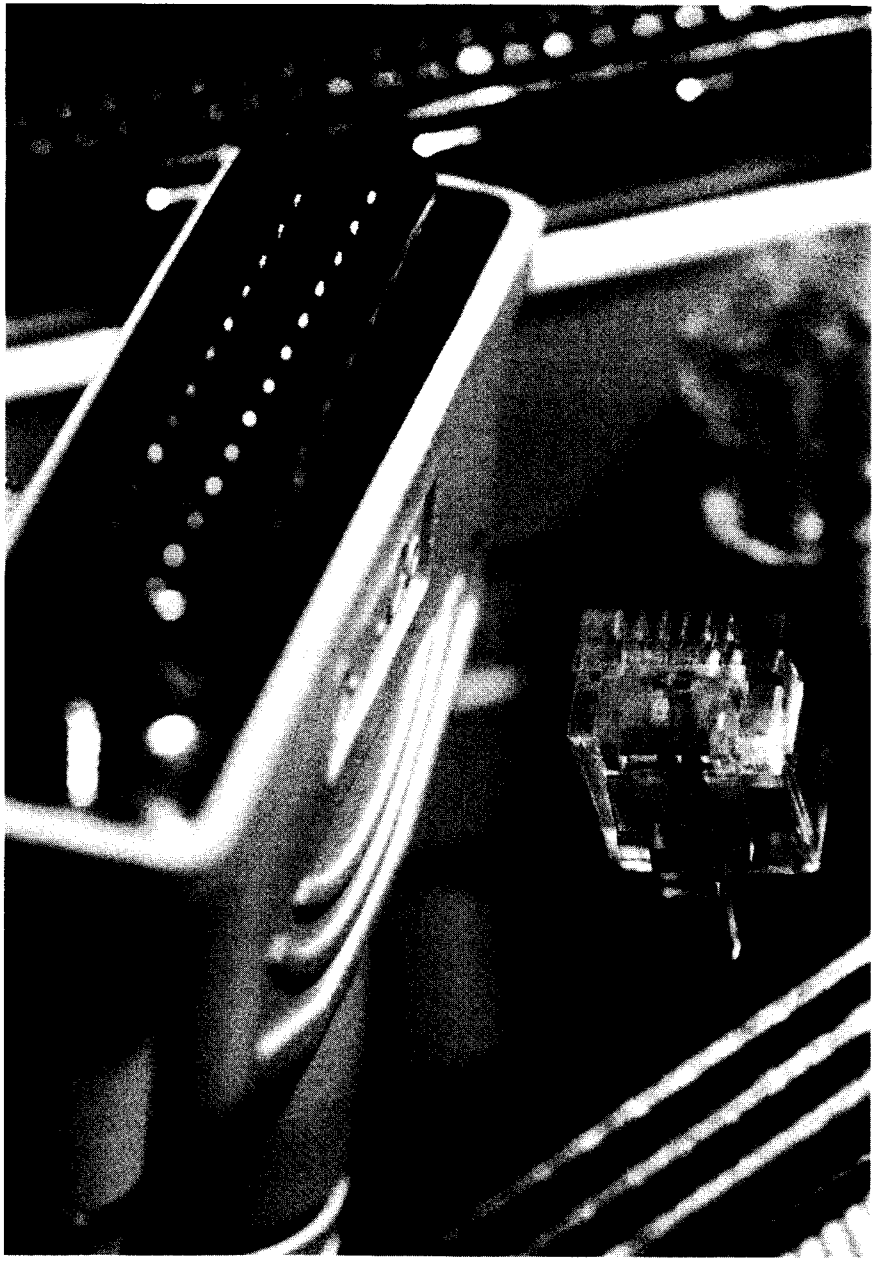
Microcomputers

Microcomputers, also known as personal computers, are affordable small computers used for tasks including writing, drawing, editing photographs, budgeting, playing games, researching, and sending and receiving e-mail. Personal computers come in a variety of sizes: desktop, laptop, notebook, and, since the mid-1990s, handheld.

Personal digital assistants **are handheld microcomputers that use either a stylus and touch screen or a tiny keyboard for input.**

Microcomputers have become so powerful that they can do much of the work once done by minicomputers and even mainframes, so the distinctions between the types of computers have become blurred. Companies that once would have used a mainframe or minicomputer now use an arrangement connecting numerous microcomputers.

The *networked* computers can access files or programs stored on *servers*—one or more shared microcomputers categorized by the type of work they do. Types of servers include file servers, application servers, mail servers, and Web servers, which hold the files that are displayed on Internet Web pages.



Parts of a Computer

Every general-purpose computer, whether a large multiuser system, desktop PC, laptop, or handheld, has the same main elements—a central processor, input devices, storage units, and output devices.

Central Processor

The brain of the computer is the central processing unit. This is the part that processes data, stores information fed into the computer, performs operations on that information, and creates output based on the results. The CPU may be a single silicon chip with millions of tiny circuits built into it.

The speed of early microprocessors was measured in thousands of cycles per second, or kilohertz (KHz); then came microprocessors measured in millions of cycles per second, or megahertz (MHz). More recent models have been measured in billions of cycles per second, or gigahertz (GHz).

The CPU in a personal computer is usually located on the main circuit board, or *motherboard*, which is like the foundation of a house. The most important components in the computer connect to it.

Collectively, the various computer chips that perform critical functions are known as the *chipset*.

Most computers have *coprocessors* to help the CPU—for example, to enhance the computer's graphics and sound capabilities without slowing down other functions.

MEMORY

One component connected to the motherboard is memory. There are two main types of memory: *ROM* (read-only memory) and *RAM* (random-access memory).

ROM is permanent memory that remains in place even when the computer is turned off. Data stored in ROM cannot be changed. Information stored in ROM is "maintained" in *BIOS* (Basic Input/Output System), a small program that starts, or boots, the computer; checks its components; and launches the operating system.

RAM is temporary memory. When you launch an application program, it is loaded into RAM. So is information that you put into the computer during a particular work session. RAM remembers this information only while the computer is turned on. If you turn off the computer, everything in RAM is lost. The exception to this is *flash memory,* a type of RAM that retains data after the device is turned off. Flash memory chips are found in digital cameras, portable audio recorders, handheld computers, cell phones, and other devices.

CONTROLLERS AND PORTS

In addition to memory, on the motherboard you often find a graphics controller, a disk controller, expansion slots, and several ports. A graphics controller tells the monitor how to display information on the screen. A disk controller tells a removable disk or hard disk how to store information for later use.

Ports are connectors that allow you to attach any number of things—monitor, printer, modem, mouse, or keyboard—to the computer. Many computers use the same *USB* (universal serial bus) ports for connecting *peripheral* devices. Another type of high-speed port is the *firewire* port, often used to transfer large files such as video footage to, or from, the computer.

The cursor is a blinking line that shows where on the screen the next character you type will appear.

Input Devices

The keyboard is used to type letters and numbers into the computer, and to move things around on the screen. Computer keyboards usually feature a row of function keys across the top that can be programmed to do different tasks and a set of arrow keys that allow the *cursor* to be moved around the screen.

Most keyboards use the standard QWERTY key layout. Designed during the 19th century to separate certain letter combinations to help keep mechanical typewriters from jamming, the QWERTY layout represents the order of the letters, reading from the left, on the top row of alphabet keys.

A *mouse* is another device used to input information into a computer. It may have a roller ball with two wheels that sense the direction in which the mouse is being dragged across the desktop or mouse pad. An *optical* mouse will use a small light-emitting diode that bounces light off the desktop into a sensor that detects the mouse's position. A mouse might have buttons that can be programmed to perform different tasks, and some have a scroll wheel on top for moving the cursor rapidly up and down the screen. The mouse also can be used to draw pictures, resize windows or boxes, and otherwise manipulate text and graphics. Other pointing devices are trackballs, joysticks, and pressure-sensitive tablets.

Sound digitizers are used to convert sounds humans can hear, such as voices or music, into a form that the computer can understand. Some computers are equipped with *sound cards,* which hold the circuitry for recording and reproducing sound, so that you can record directly onto your computer. A sound card usually has an input jack to receive signals from a microphone or an external music source such as a CD player, and it connects to jacks into which you can plug speakers and headphones.

A *scanner* is used to convert printed words or pictures into digital form that can be saved on the computer as a file. After text is scanned, an optical character recognition program can convert the words into a form that can be edited on the computer. A scanned picture image can be manipulated with graphics software.

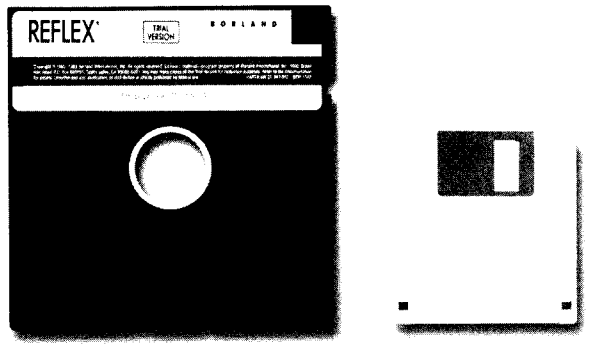
A *sensor* is a type of input device that can be used to check physical conditions such as temperature, light, pressure, magnetism, motion, and moisture. The sensor takes a reading and converts the information into a digital format so that the computer can understand it. Sensors are used in scientific laboratories to track experiments, and in manufacturing to guide robots and their movements. A light-sensing computer chip, which converts photons into digital impulses, is a special type of sensor that is used as the main component of a digital camera.

Storage Units

Storage units save information and programs for later use, even when the computer is turned off. Most storage is either magnetic or optical. A third type, flash memory, holds data in nonvolatile computer chips, which retain data even without constant electric power.

Magnetic memory works on the same principle as audio or video tape. The disk material is coated with tiny particles that will hold a magnetic charge. When a file is stored on the disk, a pattern of positive and negative particles is created. The computer's disk drive *reads* these charged particles to interpret the file; it can also change the charge of the particle by *writing* to the disk.

Magnetic storage is usually in the form of a diskette, *hard disk, high-capacity disk,* or *tape drive.*



Early versions of floppy disks, or diskettes, were flexible, but because of their hard case, today's floppies no longer flop.

A diskette consists of a thin film disk inside a hard plastic case. Easily inserted and removed from the computer, a diskette is useful for transferring text files from one computer to another, but its capacity is too small to be of much use in transferring larger files, such as photographic images, music files, or program files.

A hard disk is made up of a series of stacked, rigid, circular disks, or platters, that spin on a thin cushion of air at up to 10,000 revolutions a minute. Each platter in the hard disk has its own read/write arm that moves across the surface like the arm on a phonograph record. But instead of a needle, the read/write arm contains a read/write head that transfers data to and from the disk.

Information on diskettes and hard disks is organized in *tracks*—concentric circles much like the grooves on a phonograph record—and *sectors,* which are shaped like pieces of a pie. On a single track, two or more sectors together make up a cluster. A file that you save to the disk—for example, a book report, photograph, or song recording—may be scattered across hundreds of different clusters, but the disk keeps a directory that tells the computer which clusters hold the pieces it needs to reassemble the complete file. Because it does not have to search the entire disk, the computer finds the information quickly.

Hard disks can be fixed inside a personal computer or other device like a portable music player, or they can be made as removable cartridges. They can hold much more information

than other magnetic disks, so they are used to store programs and files of all types. Early hard disks held only 10 megabytes of information, while today's hard disk has a capacity of up to 1 terabyte, large enough to hold 500 million typed pages.

A tape drive uses a cartridge with a long piece of magnetic tape wound inside it. The cartridge head reads or writes the information on the tape as the tape passes over it. Because they only read tape from beginning to end—they can't jump around at random the way a disk drive reads a disk—tape drives are slow at accessing information. Most tape drives are used only for backing up information in case the computer is lost or damaged.

Optical storage devices can hold very large amounts of information, and the disks are relatively inexpensive. *CD-ROM* (compact disc read-only memory) and *DVD-ROM* (digital video disc read-only memory) are examples of optical storage. With these devices, information is stored using a laser rather than magnetically (just as with a CD player). A laser burns tiny pits into the surface of a disc. The flat areas between pits are called lands. The laser can later read these pits and lands as binary code.

The following table compares the typical storage capability of different media.

Media Storage Capacity

Medium	Typical Capacity	Equivalent Size
High-density diskette	1.4 megabytes	720 typed pages or 80 seconds of music
Zip disk	100 megabytes	50,000 typed pages or 1.6 hours of music
Portable USB flash drive	128 megabytes	64,000 typed pages or 2 hours of music
CD-ROM	700 megabytes	350,000 typed pages or 11 hours of music
Removable hard drive	2 gigabytes	1 million typed pages or 33 hours of music
DVD-ROM	4.7 gigabytes	2.35 million typed pages or 78 hours of music
Fixed hard drive	80 gigabytes	40 million typed pages or 1,320 hours of music

Output Devices

The *monitor* is like a television that allows you to see the output of the computer. A monitor displays information by using *pixels*—single dots on the screen. Groups of pixels form text or pictures on the screen. A monitor can have different *resolutions* depending upon how many pixels the screen can display. The more pixels it can show, the higher its resolution and the sharper the picture.

A monitor described as 1,280 x 1,024 resolution can display 1,280 pixels across and 1,024 up and down, a total of 1,310,720 pixels at one time.

Monitors can display information in black and white *(monochrome)*, shades of gray, or color. They can be a cathode-ray tube or a liquid crystal display, also known as a flat-screen or flat-panel monitor. A CRT, the older form of monitor, is less expensive and displays truer colors than an LCD but is bulkier, heavier, and uses more energy.

A sound card, described previously as an input device, also functions as an output device. It takes sound stored in digital form that computers understand and converts it to *analog* form. Once the sound is converted, it is sent to a speaker, either inside the computer or attached to it, which generates the sound that you hear. It might also output sound to a jack in which you can plug headphones for listening.

Printers

A *printer* allows you to print out text and images on paper. The quality of a printer is determined by several characteristics:

- How sharply and quickly it can print
- The quantity and variety of paper it can hold
- In the case of a color printer, how true is its color reproduction

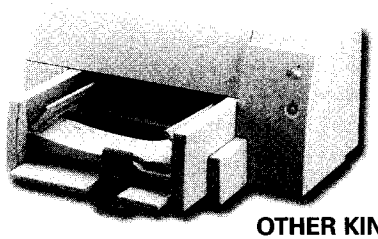
There are several different technologies used to print. Most commonly used with personal computers are *laser printers* and *ink-jet printers*. Other types include *thermal printers, impact printers, plotters,* and multifunction printers.

LASER PRINTERS

A laser printer works like a copy machine. A laser traces the image's dot pattern onto a photosensitive drum. As this drum rotates, another drum leaves toner particles on the charged area. A wire pulls the toner off the drum and deposits it onto the paper. Another roller then heats the toner and presses it permanently to the paper. Most laser printers are monochrome and are best suited for printing text and simple graphics. They are common in offices but have become affordable enough for home use as well. Color laser printers are now available but are expensive.

INK-JET PRINTERS

Ink-jet printers use liquid ink that is shot like a jet through tiny nozzles in the print head. The ink is forced through the nozzles as the head moves across the page, leaving a series of tiny ink dots that dry to form an image. Ink-jet printers typically have four colors of ink: cyan (blue), magenta (red), yellow, and black. Combinations of the four, referred to as CMYK, produce a broad range of colors.



OTHER KINDS OF PRINTERS

A thermal wax printer uses a ribbon that has bands of wax-based color inks. A heated print head melts the inks onto the paper, where they harden. In a dye-sublimation thermal printer, colors from a ribbon are heated, vaporized, then applied to the paper in a continuous tone (rather than as dots) in a series of passes. This process produces photographic-quality images and typically is used for making prints from digital cameras.

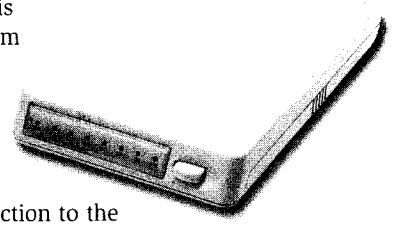
Impact printers use a series of pins arranged in a dot matrix to form letters and pictures. For example, there might be a total of 24 pins arranged 4 pins across and 6 pins down. Wherever there is a dot to be printed, the pins strike a ribbon that leaves ink on the page. The printer head then moves over slightly to print the dots in the next matrix.

Plotters are used primarily for engineering and architectural drawings. A series of pens is controlled by moving arms to actually draw individual lines on the paper.

Connecting Devices

Devices used to connect computers to one another can be considered both input and output devices. Ethernet is the most common technology for connecting computers in a *local area network*—typically, computers located in the same building. Each computer in the network has an Ethernet card and plugs into the network with a cable.

For connecting distant computers, a *modem* is required. Modems convert information from a form that a computer understands to a form that can travel over a telephone line. Once information gets to the computer on the other end of the line, another modem converts it back into a form that the computer can understand.



Modems are used to provide a dial-up connection to the worldwide network of computers known as the Internet. Standard modems send data at speeds up to 56 kilobits per second. Several types of faster modem connections, known as *broadband,* are also available. Typically, they deliver data at speeds from 256 kilobits up to 1.5 megabits per second, or 5 to 30 times faster than the fastest dial-up.

Digital subscriber line technology uses the same copper telephone lines as a standard modem, but because DSL produces a higher-frequency signal than voice communications, you can transfer data and chat with a friend over the same phone line at the same time.

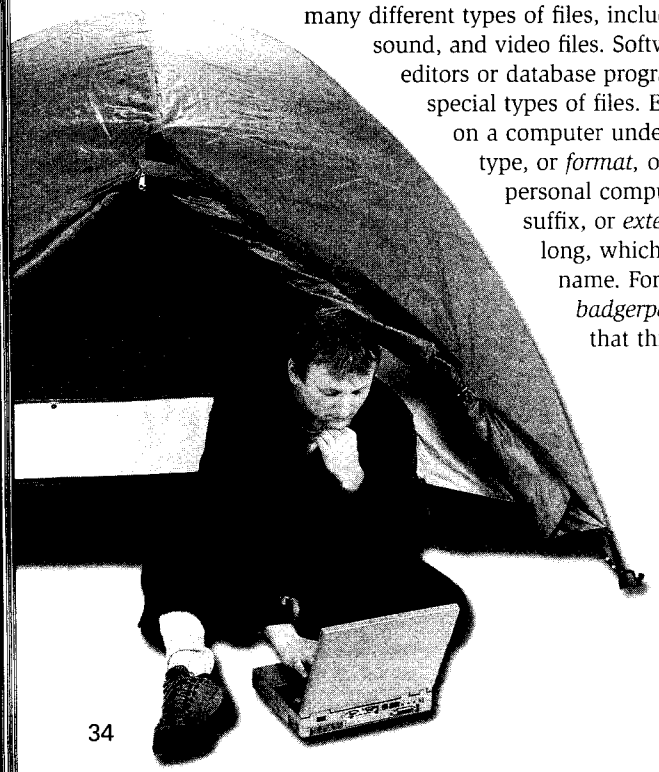
Broadband also can be accessed by cable and satellite service. A cable modem uses the same coaxial cable that brings cable television signals into your home. A satellite Internet connection is beamed from an orbiting satellite to a roof-mounted dish on your home and transferred by cable to your computer. Satellite service is commonly used to bring broadband access to areas where DSL and cable are not available.

Wireless fidelity connects a computer to the Internet wirelessly over a short distance. Typically, the DSL, cable, or satellite modem connects to a base station or *router.* A special wireless card attached to a remote computer receives radio signals sent out from the router, establishing an Internet connection over the airwaves. Increasingly, coffee shops, airports, and other businesses are setting up Wi-Fi–equipped stations where customers can connect their portable computers to the Internet.

Understanding Data and Files

Information stored on your computer is called *data.* The data may have been entered into the computer with an input device—say, a list of names you typed on the keyboard. Or, the data may have been created by the computer as output—for example, address labels created when a word processor merged the list of names with street addresses written in a second list.

Almost all data is stored in the form of files. There are many different types of files, including number, text, picture, sound, and video files. Software programs, like graphics editors or database programs, may create their own special types of files. Each file is saved or stored on a computer under a different file name. The type, or *format,* of the file stored on most personal computers is identified by the suffix, or *extension,* usually three letters long, which follows a dot after the file name. For example, in the file name *badgerpatrol.txt,* the ".txt" indicates that this is a text file.



What Extension, Please

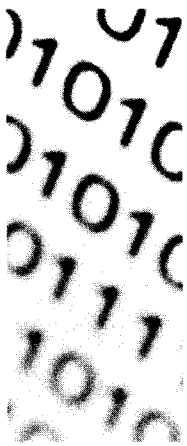
It is important to use the correct extension when creating a file name, particularly if the file will be e-mailed to another computer or viewed on a Web page. If the servers that display Web pages or help send e-mail can't read those extensions, they can't tell the receiving computer what sort of file it is receiving—and the recipient won't be able to process the file.

There are thousands of different types of files and file extensions. Some can be read only by a specific brand of computer. However, many popular file formats can now be read on either operating system so long as the computer is running the required software.

Extension	File Type
Text files	
.txt	ASCII text
.doc	Microsoft Word® (word processing)
Image files	
.jpg	Popular for saving photographs; adjustable compression ratio to achieve exact desired file size
.gif	Nonphotographic images such as icons, buttons, drawings, and figures
.png	Image format with better color reproduction than .gif
.bmp	Short for bitmap, a standard Windows® graphics format
.tif	Offers a lossless way to compress graphics; produces much larger file than .jpg
Sound files	
.mp3	High compression of sound data with only a slight loss in quality
.aiff, .au	Macintosh®-platform sound file
.wav	Windows®-platform sound file
.aac, .wma	High compression; even better quality than .mp3 file
Video files	
.avi	Windows® video file
.mov, .mpg, .mpeg	Movie file in Mac® or Windows® platform

Storing Data

Let's look at some main types of data and how they are stored on the computer.



Numbers

Think of your computer as a collection of billions of circuits, each with just two positions, off and on. These two positions are represented by the numerals 0 and 1, which make up the binary number system. All data is stored in the computer as groups of 0s and 1s.

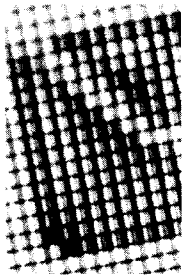
Each individual numeral is called a *bit,* short for binary digit. Bits are clumped in larger groups, usually of eight bits each, called *bytes.* It takes one byte to represent each of the numerals in the decimal number system, which uses the symbols 0 through 9.

Binary numbers do not look much like decimal numbers. For example, written as a binary number, the decimal numeral 9 is 00001001. Binary numbers make up *machine code,* the low-level language that computers translate all data into before performing operations on it.

Text

Text is stored using *ASCII,* a special code corresponding to the numbers between 0 and 255. Similar to the way it stores decimal numbers, the computer represents each text character as a single byte of information. For example, the letter A is assigned the number 65 in ASCII code, which is 01000001 in binary form. ASCII text is stored without any formatting, such as indentations or boldface.

An ASCII text file is often referred to as a plain text file and can be read by almost any word-processing program. Depending on the program, you can add formatting and save the text in another format.



Pictures

Pictures often are stored as a series of small dots called pixels. Your monitor might display, for example, 1,024 by 768 pixels. This means that each horizontal row contains 1,024 pixels, and there are 768 of these rows stacked vertically.

If your monitor is black and white, each pixel requires only one bit of information, telling it to display either 1 (black) or 0 (white). If the monitor is *grayscale,* it designates up to 256 shades of gray between black and white for each pixel.

Color CRT monitors use three electronic beams—red, green, and blue. Each color beam scans the screen and electronically paints each pixel with a certain amount of color, which when combined with the others produces the desired final color.

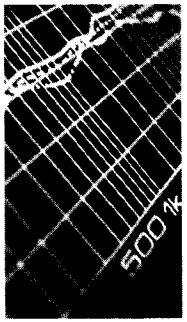
Eight bits of information per pixel will produce 256 different colors on the screen. Sixteen bits will produce 32,767 different colors, and 24 bits will produce 16.7 million different colors—the maximum number of colors the human eye is believed to be able to distinguish, sometimes referred to as *true color.*

COMPRESSION

Picture, or image, files are stored in many different formats. Some of these formats *compress* the picture, making the file smaller so that it takes up less disk space and is easier to e-mail or transmit over the Web.

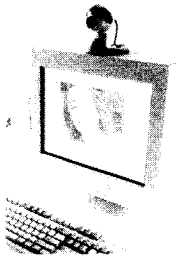
The type of compression used in some picture formats is lossy compression, in which some data is lost forever. Another type of compression, called lossless, can temporarily shrink a file by removing parts that are repeated and then, later, restore the file to its full size. Lossless compression is used with text, database, and other kinds of files in which the loss of a single bit of data would render the file unusable.

Sound



Sound that enters your computer through a microphone or CD player arrives as an analog signal consisting of sound waves, or vibrations that travel through the air. The computer sound card feeds this signal through an analog-to-digital converter chip that converts the signal into bits that the computer can read and save as a digital file. When you play back the file, the data is sent through a digital-to-analog converter chip, which rebuilds the shape of the wave and sends that information to the speakers, which vibrate the air, recreating the original sound wave that you can hear.

Video



Faster microprocessors have made it possible for computers to display moving pictures. Today's computers can store entire movies on their hard drives, including home movies shot with digital video cameras.

Digital video, even when compressed, uses up enormous amounts of storage space, but as hard drives get larger, more and more people will use their computers to store and edit their video collections.

Computer Software

Programming languages are used to write other programs.

Software, a set of instructions organized into a program, is what makes hardware work. A software program tells the computer specifically what to do. There are two main categories of programs:

- *Operating systems* control the computer's basic operations.
- *Application programs* allow the computer to do a specific job, such as compose a letter or touch up a photograph.

Operating Systems

Operating system software is the foundation software on which all other programs run. It is actually a set of programs that control all of the computer's basic operations. This includes accepting input from the keyboard, displaying output on the monitor, keeping track of files and directories on the hard drive, and controlling peripheral devices such as disk burners, printers, scanners, speakers, and the mouse.

Because of the work done by the OS, programmers who create application software do not have to write code into their applications to control these basic functions. Likewise, the OS manages upgrades to a computer's hardware (installing more RAM, for example), automatically updating settings in the rest of the system.

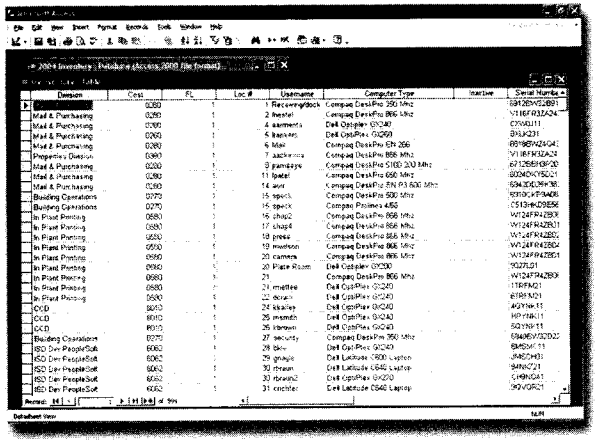
The OS also serves as a kind of traffic light, allocating processing power and memory space among the various programs that might be running at once—while holding back some resources for use by the OS itself.

The most common operating systems are the Windows® series (the latest is XP), the Macintosh® series (its latest is System X), and the Unix® family of operating systems.

Applications

There are thousands of application programs. As computers become more powerful and as people think up new ways that computers can help us at school, work, and home, new application programs are continually being written.

The following are some of the most popular types of application programs, though there are many others adapted to special needs in science, business, and industry.

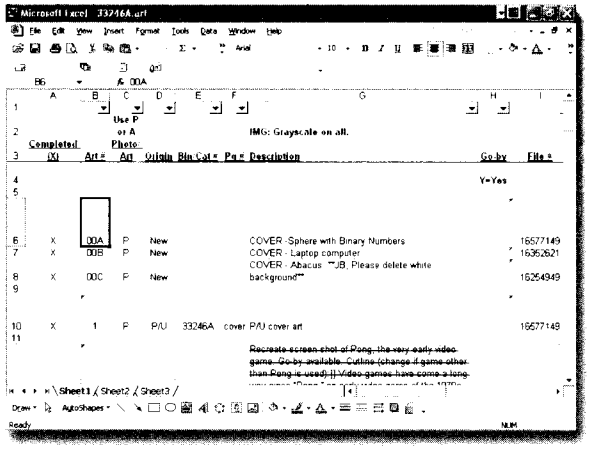


Database manager program

Database managers are used for organizing, storing, and keeping track of a set of information, called a *database.* The data are organized in lines called records, with each record consisting of a number of fields. For each new record, the same set of fields, with different contents in each field, is stored. A good DBM can perform complicated sorts and searches of the database and produce neatly printed reports with bar graphs and pie charts.

For example, a troop attendance database could be set up with a record for each Scout's name, patrol, and rank, and for each troop meeting, campout, or other event.

An entry of "present" or "absent" could be made in the appropriate field of each Scout's record after each activity. The Scoutmaster could then easily print out a roster of Scouts who attended a particular event. He could also use the DBM program to calculate the percentage of activities attended by each Scout.



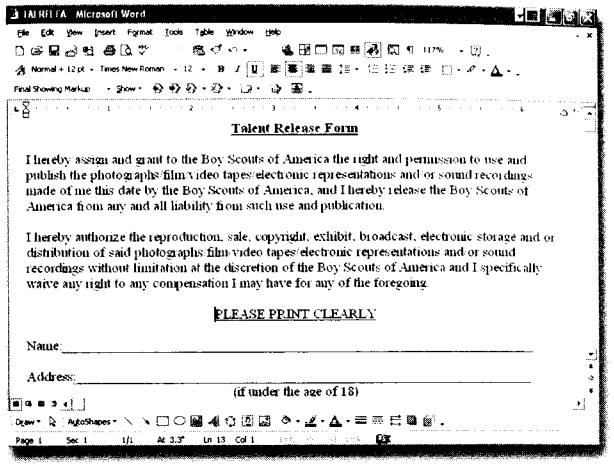
Spreadsheet program

Spreadsheets are among the first and most useful programs developed for the personal computer. A spreadsheet performs arithmetic on numbers arranged in rows and columns, and displayed in a table. The boxes formed by the numbered rows and lettered columns are called cells. A formula is a function performed on numbers in particular cells—for example, adding the number in cell A1 with the number in cell A2, and having the sum appear in cell A3.

Spreadsheets allow you to perform "what if" operations. If you change a number in one cell, the program immediately recalculates the totals in the other cells that are affected by your formula. For example, you can figure out how many more Scouts could go to summer camp if the troop raised an additional $300 at car washes, or an additional $400, or $500.

Word processing software programs are tools that make writing and formatting text easier. Once words are typed into a document, they can easily be rearranged and corrected. Software may allow you to change the size, style, and even color of the letters. You can easily align your paragraphs to the left, right, or center, add bullets or underlining, adjust the amount of indentation at the beginning of a paragraph, and alter the depth of your margins.

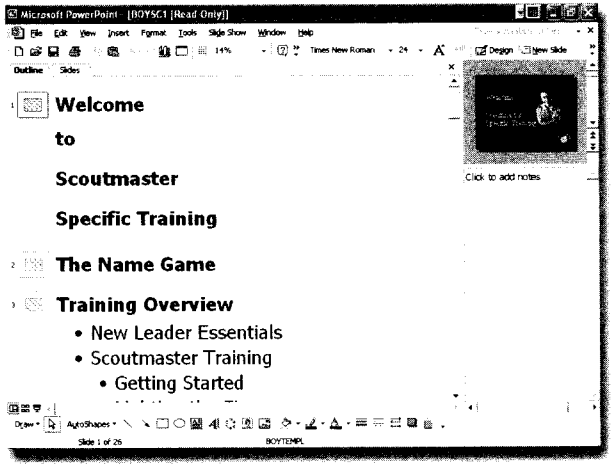
Some programs let you add tables and graphics and will automatically number your pages. You can make different versions of your documents without completely retyping them, check your spelling, and produce neat printouts.



Word processing program

With the mail merge function, names and addresses from a database program can be added to a form letter you have written to send out to a large group—for example, to every Scout in your troop.

A **presentation program** is a popular aid for public speaking, featuring screens or slides that list important points of your speech, as well as pictures, charts, graphs, and even sounds and animation. The slides you create can be projected



Presentation program

onto a screen in front of your audience and advanced as you move along in your speech. The text and graphics portion of your presentation can be printed out and distributed to your audience. Your presentation can be saved as a file and updated and modified for later use.

Desktop publishing programs allow you to design a page with a variety of elements, including words, pictures, and drawings. These programs include tools for formatting text—such as writing a headline in big, bold type—sizing images to fit into your layout, and adding color backgrounds, shading, boxes, lines, and other design elements. You can design a newsletter, a poster, or even a book on a desktop publishing program.

Graphics and design programs allow you to create and edit pictures and drawings on a computer. Some programs draw in two dimensions and are known either as paint or draw programs. Other programs allow you to draw in two or three dimensions and create sophisticated models. These programs are known as *computer-aided design,* or CAD, programs.

Three-dimensional CAD programs can be used to create wire-frames, or outlines, of objects and solid models, which can show texture, light, and shadows. CAD programs are used by automotive engineers to design entire automobiles down to each individual part and by architects to show every facet of a building before construction.

Photo-editing programs serve as a sort of digital darkroom, allowing you to enhance pictures by cropping, sharpening, adjusting brightness and contrast, deepening color saturation, correcting color hues, and otherwise improving your pictures, and then letting you print them out or save them as computer files. **Photo album** programs help you organize your picture collection electronically on your hard drive or compact disc, rather than just stuffing your prints into a shoe box. This software may also let you create slide shows of your pictures that can be stored on a CD or DVD.

Video editing programs turn your computer into a digital movie studio, allowing you to edit and enhance video footage taken from a digital camcorder or converted from an analog camcorder. Simple forms of this software come bundled with digital video cameras, or you can buy more powerful video editing programs separately.

Web page editors are programs that help you create Web sites without having to write HTML, the most common formatting language used on the World Wide Web. Typically, these programs allow you to design your page—positioning text and graphics—by selecting commands from toolbars and icons. The editing program automatically creates the code needed. Most Web page editors allow you to add features like animation and scrolling text. The programs also offer some help in publishing the Web pages you have created onto the Internet.

Communications programs allow you to connect to other computer users around the world, and to millions of companies, services, universities, schools, libraries, and individuals who maintain Web sites (see "The Internet and World Wide Web").

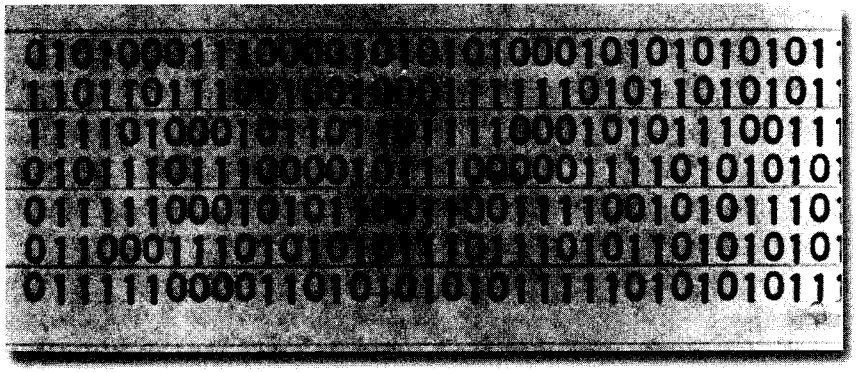
The connection software provided by your Internet service provider usually comes with an e-mail program for creating, sending, and saving electronic mail, as well as an address book for storing e-mail addresses. It also usually offers a Web *browser* for viewing Web pages, or you can select another Web browser to run after your Internet connection is established.

Keep Safe

It is important to protect your computer against malicious programs and intruders by using an antivirus program and a *firewall,* especially if you connect to the Internet over a high-speed or broadband connection.

Programming Languages

A program is a set of instructions that tells a computer how to accomplish a particular task. A programmer is the person who writes the instructions. A programming language is the tool that an operator uses to convert the instructions he or she writes into a format that the computer can understand. There are dozens of different programming languages, just as there are dozens of different spoken languages, each filling a particular need.



Machine code

Early programs were written in machine code, the only language the computer's circuits can read. It is a low-level language that is hard for people to understand and very tedious to write. A program written in machine code consists of thousands or millions of 0s and 1s! A slightly more human-friendly code is assembly language, but it, too, is specific to a particular type of computer and is also considered low level.

As high-level languages were developed, programming languages became easier for people to write and understand because they consist of English-like commands. However, a program written in a high-level language must be translated, or compiled, into machine code before the computer can understand it. Programs written in high-level language are usually referred to as source code. A *compiler* program converts this source code into machine code, also called object code.

High-Level Languages

Examples of high-level programming languages of the past include COBOL, FORTRAN, BASIC, Pascal, and C.

COBOL is popular for business-oriented data processing on larger computers. It was designed for use by banks, utilities, manufacturers, government agencies, and other big operations.

Developed in the 1950s, **FORTRAN** was one of the earliest programming languages. It is well-suited for mathematical calculations and is used primarily for scientific and engineering programming.

BASIC was invented in the mid-1960s as an easy, all-purpose language for beginning programmers.

Pascal (named after the French mathematician Blaise Pascal) was designed as a teaching tool but now is often used in scientific programming.

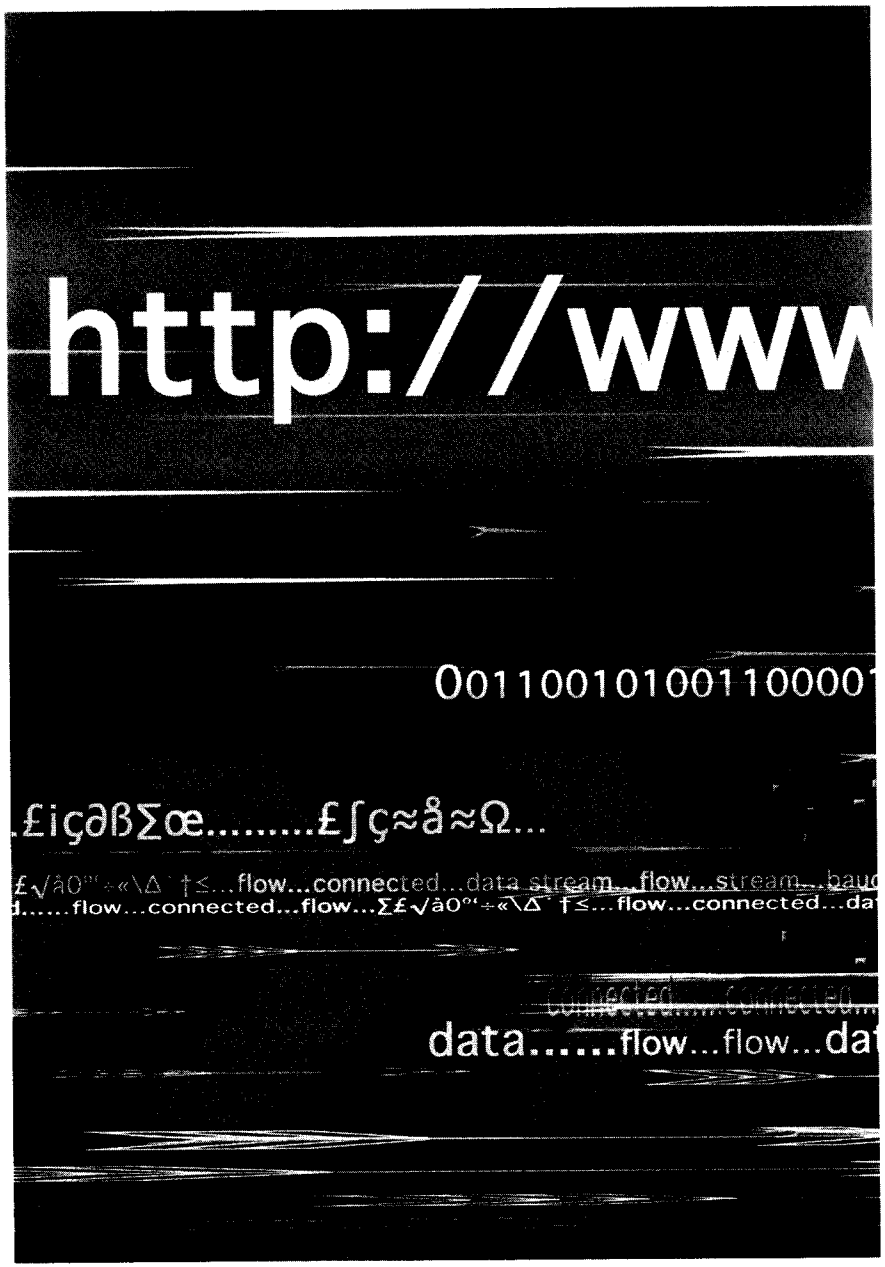
The popular programming language **C** was designed to work on a number of different computers and can easily be converted to work on a different size or type of computer.

Object-oriented languages such as C and Java have become popular. Such languages put together groups, or modules, of commonly used commands, such as instructions on how to print, how to save information to a disk, etc., and convert them into complete programs. Object programming saves time because the programmer can reuse parts of existing programs. Programming this way is more like putting together pieces of a puzzle than trying to design each individual piece.

Web Languages

The popularity of the World Wide Web has spawned languages for building Web sites and performing computing operations over the Internet. The basic language for displaying text and pictures on Web sites and linking different Web pages together is **HTML,** short for *hypertext markup language.* It is a simple language to learn how to write.

To soup up a Web site by adding motion and interactivity, programmers use scripting languages such as **JavaScript** and **VBScript.** Programs written with scripting languages are important for conducting business over the Web. They allow customers to interact with the computers that operate the Internet store or business.



The Internet and the World Wide Web

When three or more computers are linked together to communicate with one another, their connection is called a *network*. It might be a local area network contained within a single building, or a wide area network covering a whole region of the country.

These small and midsized networks are linked in turn to form a much larger system spanning the whole Earth—the Internet. The Internet, simply stated, is a network of networks. When connected to the Internet, any computer can communicate with any other computer around the globe that is also connected to the Internet.

The Internet does not rely on any one central computer to operate, nor even a central network. No one organization controls it. Instead, the Internet operates across numerous high-speed networks maintained by various Internet service providers and private networks operated by different companies.

The different networks connect at network access points. If one part of the Internet is blocked or damaged, information finds a different pathway to reach its destination. This is possible because all information sent through the Internet is broken up into clumps, or packets, of data, each with its own addressing and identifying information and error-correction code.

When you send e-mail or files to friends on the other side of the world, each message becomes a "packet." Each packet has a header—similar to a mailing label—that is read by special computers called "routers." These routers forward your packet along the most efficient path at that moment, until it reaches your friend's Internet service provider's mail server. The message will then be downloaded and "delivered" to your friend's electronic mailbox. At their destination, the packets are

pieced back together into the original file or e-mail message and checked for errors. This packet-switching technology, called TCP/IP, makes the Internet possible.

World Wide Web

By 2004, more than 4 billion pages had been indexed on the Web.

The Internet traces its origin to ARPANET, a small network launched in 1969 by the Advanced Research Projects Agency within the U.S. Department of Defense. When researchers developed a way to link that network with others around the world, the Internet was born. As the Internet grew, a better way was needed to access and display the vast stores of information it held. That better way was the World Wide Web, developed in 1990 by **Tim Berners-Lee,** a physicist who worked at CERN, the European Organization for Nuclear Research, which is a particle physics laboratory.

The Web would bring graphics, pictures, sound, animation, and video to the Internet, but the Internet's true brilliance was in how it provided a simple system of organization.

One of Berners-Lee's two main innovations was the uniform resource locator, a form of address that can be used on any Web page or other file on the Internet. His other important invention was HTML, a computer language that creates Web pages that link to other Web pages through hypertext.

A word in hypertext can be linked by way of a hidden URL to any other page, or part of a page, or file. Simply by clicking your cursor on the linked word, you can jump to some other location on the Internet, even if it's stored on a computer far distant from the page you started on.

To view Web pages, you need a software program called a Web browser. The first popular browser, known as Mosaic, was developed by a team at the University of Illinois at Urbana-Champaign led by student **Marc Andreessen.** He would later form a company called Netscape, which produced a more widely used browser called Navigator. Since then, millions of individuals, businesses, financial institutions, schools and universities, libraries, and all levels of government agencies—from city councils to the White House—have put up Web pages on the Internet.

Protocols and Domains

Every computer connected to the Internet can be identified by a unique number called its *Internet protocol address.* A typical IP address looks like this: 168.18.99.248.

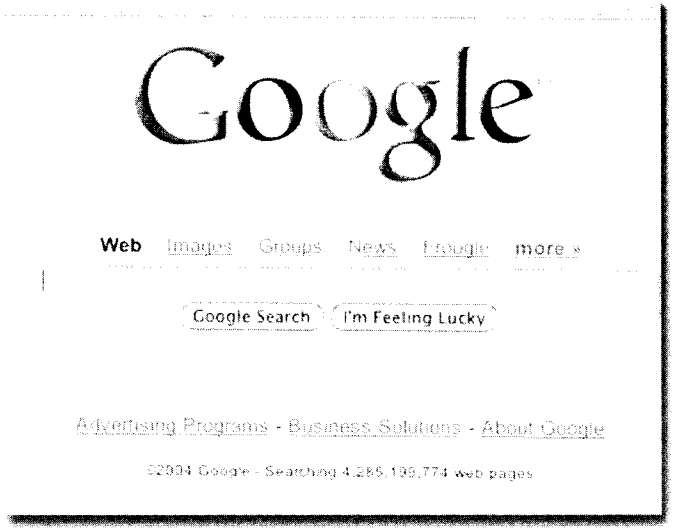
Finding computers by their IP address was difficult, so in 1983, researchers at the University of Wisconsin developed the *domain name* system, which allows you to find a computer on the Internet by a unique name connected to the IP address.

Domain names and their offshoots, such as "scouting.org" and "media.scouting.org," always have two or more parts separated by dots. The part of the name farthest to the right, the suffix, is the top-level domain:

- *.com, .net,* and *.org* are for general, commercial, and organization use.
- *.gov* is reserved for governmental agencies.
- *.edu* is for educational institutions, such as elementary schools and colleges.

Different countries have their own top-level domains, for example, *.uk* stands for United Kingdom, *.au* for Australia, and *.ca* for Canada. Web sites with those letters at the end are likely to be based in those countries. The part to the left of the top-level domain is the host name ("scouting" in the example used above).

Once a particular domain name, such as "boyslife.org," has been registered, no one else can use it. Maintaining this Internet domain name system is a nonprofit group called the International Organization for Assigned Names and Numbers, which regulates the buying and selling of domain names.



A search engine like this one at *www.google.com* can help you locate information on the World Wide Web.

There are billions of Web pages indexed on the World Wide Web—and an endless number possible.

Search Engines

To find the information you need among the billions of Web pages, you use a *search engine,* such as the ones found at *google.com* or *yahoo.com.* Search engines use programs called crawlers to explore the Web and build indexes of Web pages.

To use a search engine, you simply type in your search term, for example, "history of the Internet," click the search button, then see a list of Web pages that are related to the term you submitted. You can then click on any of the listed pages that you want to view.

It's important to remember that no one controls what information is put onto the World Wide Web, and much of what you see posted there may be incorrect or only partially correct—or just downright wrong. You must always consider the source of the information to help you evaluate how accurate it might be.

Tips for Online Safety

Some risk comes along with the convenience of the Internet. When you are online, be careful to guard your privacy and protect yourself from potentially harmful situations.

Protect Yourself

These tips will help you stay safe. Your parent, counselor, or librarian may talk with you about other rules for Internet safety.

1. Follow your family's rules for going online. Respect any limits on how long and how often you are allowed to be online and what sites you can visit. Do not visit areas that are off-limits. Just as there are places you don't go to in real life, there are places to avoid on the Internet.

2. Protect your privacy. Never exchange e-mails or give out personal information such as your phone number, your address, your last name, where you go to school, or where your parents work without first asking your parent's permission. Do not send anyone your picture or any photographs unless you have your parent's permission.

3. Do not open e-mails or files you receive from people you don't know or trust. If you get something suspicious, trash it just as you would any other junk mail.

4. If you receive or discover any information that makes you uncomfortable, leave it and tell your parent. Do not respond to any message that is disturbing or hurtful.

5. Never agree to get together with someone you "meet" online, unless your parent approves of the meeting and goes with you.

6. Never share your Internet passwords with anyone—even if they sound official—other than your parents or other responsible adults in your family.

7. Never shop online or enter a credit card number unless you have your parent's permission to do so.

8. Do not believe everything you see or read online. Along with lots of great information, the Internet has lots of junk. Learn to separate the useful from the worthless. Talk with your counselor or other experienced Web user about ways to tell the difference.

9. Be a good online citizen. Do not do anything that harms others or is against the law. Be aware that information you provide such as notes and personal remarks may be shared with others. A good rule of thumb is to not post information you don't want others, including strangers, to see.

Protect Your Computer

Besides taking precautions to protect your personal safety online, you should protect your computer from a number of online dangers, including viruses and theft of files.

Your computer can catch a virus from an e-mail message, Web site, or infected diskette. Typically, viruses copy themselves and multiply. Some even send themselves to all the e-mail addresses in your Internet address book without your knowledge.

A virus is a piece of software code designed to harm your computer in some way, such as by destroying files or causing your computer to malfunction.

These tips will help you keep your computer safe. Your parent, counselor, or librarian may talk with you about other rules for avoiding viruses.

1. Look carefully at the return address of all e-mail messages that you receive, especially those that arrive with attachments. *Download* a file only if it comes from someone you trust, and even then be suspicious. A virus sometimes can be sent from a friend's computer without his knowledge, if his computer is infected.

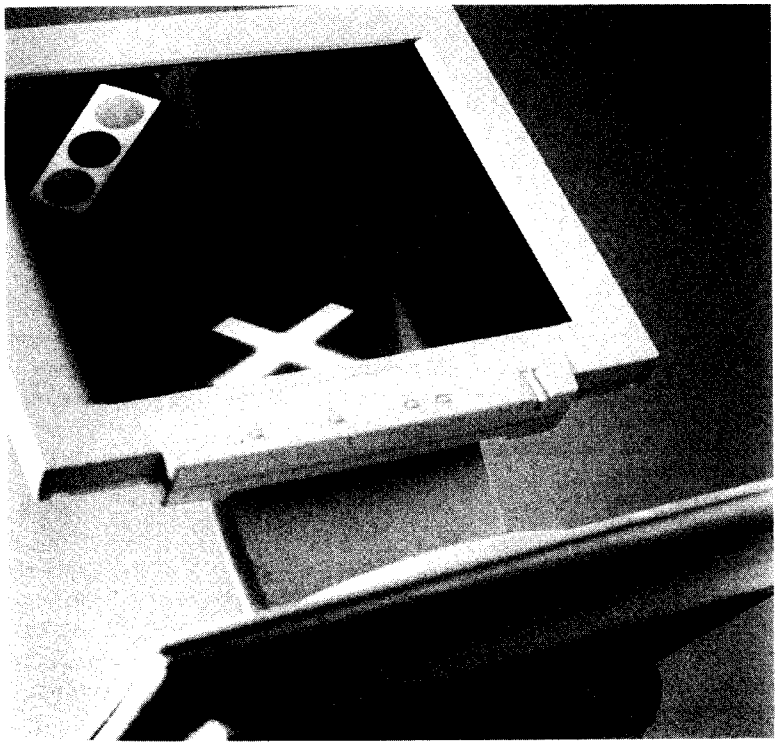
2. Install and periodically and regularly update antivirus software on your computer. The program can be set to automatically look for viruses on your hard drive, to scan disks and files that you put into your computer, and to scan e-mail attachments that you receive.

3. Don't open e-mail that appears to be spam, or junk mail, which may be merely trying to sell you something but—more importantly—could also introduce a virus into your computer.

4. Back up your important files regularly onto CDs or data compression disks to help keep from losing your important files if your hard drive is ruined by a virus (or hardware failure). Scan your backup disks for viruses.

5. Only buy software from trusted sources. Unauthorized copies of software programs often contain viruses and should be avoided.

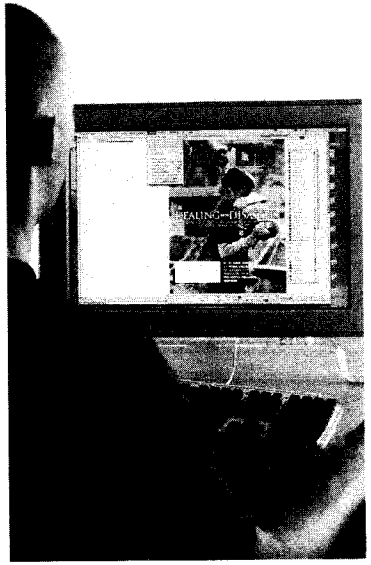
6. For added protection, use a firewall, which can consist of software, hardware, or both, to keep intruders from looking at and possibly stealing private information stored on your hard drive, such as passwords or credit card numbers.



Computers at Work

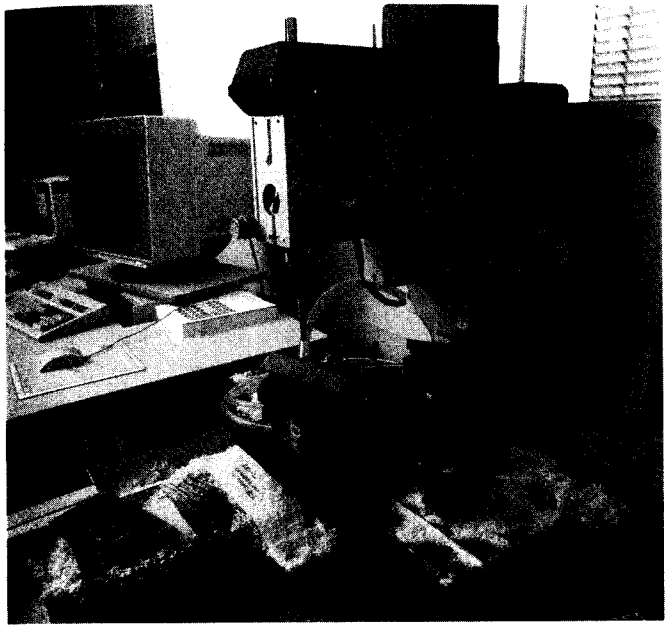
Nowadays, computer skills are useful in almost every career. As computer technology has become cheaper and more powerful, it has spread into practically all lines of work, from farming to medicine, from landscape design to aerospace.

Basic application programs—word processing, spreadsheets, etc.—are used throughout the economy. But beyond that, each industry uses specialized software, and often specialized computers, tailored to the specific needs of the profession.



Newspaper and magazine publishers use computers to edit and design print products and online publications.

- Graphic designers and special effects creators use computers to produce special film sequences for movies and television commercials.
- Air-traffic controllers use sophisticated computer systems to help them guide commercial airplanes in and out of airports.
- Music publishers record and edit music digitally using computer equipment.
- Professional translators use computers to automatically translate writing from one language into another.
- Doctors use computers to store and retrieve the medical records of their patients and to access medical information that can help them diagnose and treat illness.
- Architects use computers to help them design buildings.



Computer-driven robots are used in assembly line manufacturing, where they provide precise control of sophisticated equipment.

The computer industry itself is huge and offers many career opportunities.

Electrical engineers design hardware. Electronics technicians build and repair it. Software engineers and computer programmers design and write application software.

Information technology managers develop and manage computer systems and servers for business, industry, government, science, and health care. Schools and universities need teachers and professors who can teach computer science.

Since the 1990s, the Internet has opened up an entirely new field of computer-related careers. Today, thousands of companies maintain corporate Web sites, conduct business over the Internet, and market products through Web advertising. These companies need technicians to maintain Web servers and e-mail servers, designers and graphic artists to design Web pages, programmers to code Web pages, and technology managers to keep operations running smoothly.

Video Games: More Than Just Fun

The video game business, which today employs thousands of people, didn't exist before computers were invented. In just a couple decades, it has grown into a major industry. Annually, more than 239 million computer and video games are sold in America.

Developing a game can take months of work and can cost millions of dollars. But the profits can be very high if the game is a success. Today, the sale of computer and video games has reached $7 billion per year in the United States alone, according to the Entertainment Software Association.

Some of the types of workers employed in the video game industry include lead programmers, special-effects programmers, audio programmers, sound engineers, composers, art directors, game designers, level designers, graphic designers, screenwriters, producers, project managers, game testers, and marketing and business managers.

Many colleges, universities, and design schools are now offering courses or even degree programs in game development and digital media. For a listing of such programs, visit the Web site of the International Game Developers Association with your parent's permission. See the resources section at the end of this pamphlet.

When you visit a business or industrial plant that uses computers, find out:

1. What types of computers are used—mainframes, minicomputers, or personal computers
2. What types of software programs are most useful to the company
3. Whether any specialized software had to be written to meet the company's needs
4. How many people work in the computer or information technology department of the business
5. What kind of computer skills the company likes to see in new employees that it hires
6. How the Internet and World Wide Web have changed the way the company does business (Ask whether the company has a corporate Web site and how many employees it takes to maintain the site.)

Copyrights and Piracy

When you buy a music CD, a software program, or a DVD movie, you do not actually own the content of that product. You own just a copy of the work. You have purchased the right to use that copy with certain restrictions.

Creative products and expressions of the human mind that have commercial value are called *intellectual property.* The words and music to a song, a software program, a movie—these are examples of intellectual property. When you buy intellectual property, it is protected by various laws, including *copyright* laws.

One main restriction of copyright law is that you cannot make unauthorized copies of these works. Making and distributing illegal copies of copyrighted works is called *piracy.* Today's pirates aren't sailing the high seas—often they are people sitting at home, downloading music files or software over the Internet.

Compounding the problem is the illegal sharing of these pirated copies over the Internet through the use of file-sharing networks. These networks make piracy easy and seemingly anonymous.

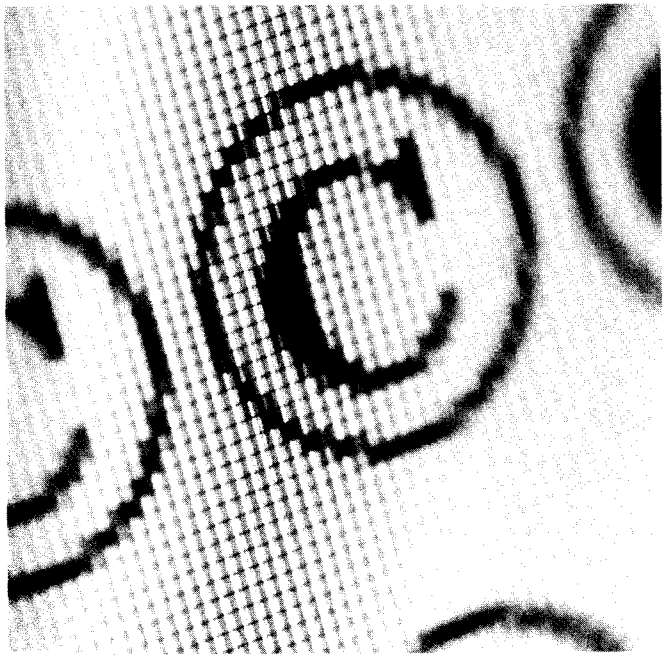
Software publishers in a recent year lost more than $2 billion in the United States alone due to software piracy, according to a study by the Business Software Alliance.

Increasingly, piracy is becoming dangerous to the pirates themselves, as both the music industry and the software industry crack down on this illegal practice. Every computer connected to the Internet has a unique IP address, which can be used to track down pirates and bring legal action against them. Some people have had to pay thousands of dollars to the recording industry for songs they pirated online.

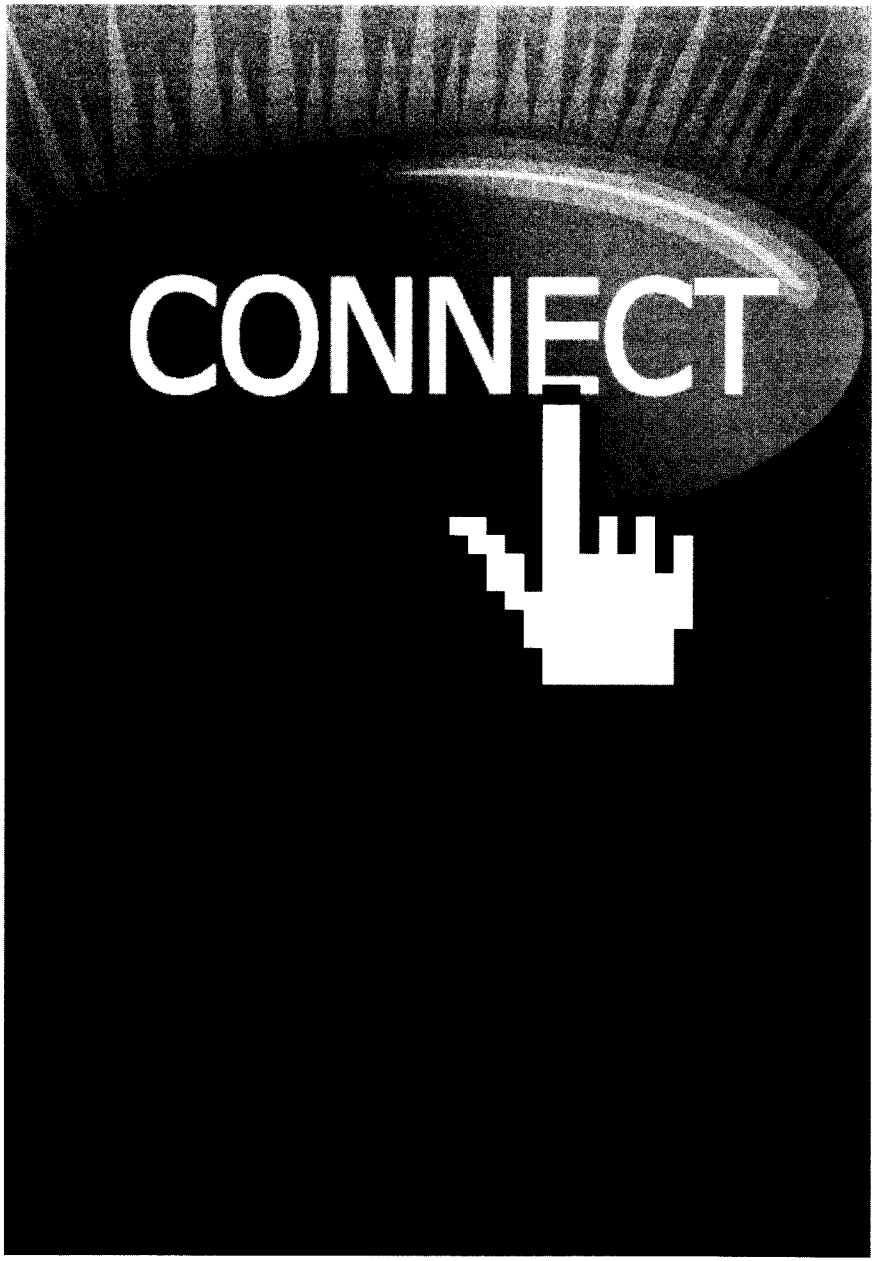
Not all copying is illegal. When you buy recorded music, you usually can copy it for your own personal use, say, in a portable music player. However, it is illegal to give copies of software or music to your friends. If you do, you are committing a crime. When you download pirated files into your computer, you also run the risk of downloading a virus that can harm your computer and data files.

There are legal ways to get music and software over the Internet. Numerous online music stores now make it easy to buy single songs or whole albums for downloading over the Internet without breaking the law. Likewise, some software, called *shareware,* can be downloaded or shared on a disk legally.

Some publishers also allow you to download a trial version of their software so you can try it out for a limited number of days. After the trial period is up, you must purchase the software if you want to continue using it, or else the software will no longer work. Yet another type of software is called *freeware,* which you can download and use for free. (You also can make copies of it and give it away.) However, freeware is copyrighted and is protected by copyright laws.



All software, whether it is commercial, shareware, or freeware, has its own licensing agreement. It is important to read these agreements carefully to make sure your specific use of the software is in line with its intended use.



Glossary

abacus. A counting device made of a series of beads on a frame.

analog. Describes a device or information that is continually variable, like a clock or a sound wave. The opposite of *digital.*

application software. Software or a program that is used to do specific tasks with a computer, such as writing or drawing pictures.

ASCII (American Standard Code for Information Interchange). A code made up of eight-bit characters that is understood by many different computers.

BIOS (Basic Input-Output System). Built-in software that controls many basic functions of the computer, often stored in ROM or flash memory.

bit. Short for *binary digit;* the smallest possible unit of computer information. Each bit represents one switch in the computer that can be on or off.

broadband. A transmission channel with high data capacity and high speed, able to carry video, audio, and data at the same time.

browser. A program that lets you find and explore information on the World Wide Web, including text, graphics, sound, and video.

byte. A binary character, consisting of eight bits of information, which may describe a letter or number.

CD-ROM (compact disc read-only memory). An optical storage medium, identical to audio compact discs, that stores hundreds of megabytes of data.

central processing unit (CPU). The "brain" of the computer, where most of the calculations take place.

chip. A sliver of silicon used to hold transistors and other electronic parts.

compiler. A program that decodes instructions written in a programming language and then translates, or compiles, them into machine language.

computer-aided design (CAD). Describes programs used by engineers and architects to design parts, machines, and buildings with a computer.

compression. Shrinking a file. Compression can be lossless (preserving all the data in a file) or lossy, in which some data is discarded.

computer. A system that processes and manipulates information.

coprocessor. A special chip that helps the main "brain" of the computer to work faster at certain tasks, such as math or drawing.

copyrighted. Describes written material, including text, pictures, sound, movies, and software, that is legally protected from being copied or sold without the author's permission.

cursor. An indicator on a computer's monitor that shows where the next character will go.

data. Information.

database. A collection of pieces of information that fit together in some way or have something in common.

database manager (DBM). Software that lets you keep track of information such as names, addresses, and telephone numbers.

digital. Using numbers to perform, store, and display a computer's calculations.

domain name. The unique name linked to an IP address, always written with two or more parts separated by a period.

download. Transferring information "down" from someone else's computer to one's own computer, by way of a peer-to-peer connection network connection, or via the Internet.

DVD-ROM (digital-video disc read-only memory). An optical storage device capable of holding 4.7 gigabytes of data.

e-mail or electronic mail. A message sent from one person to another using a computer.

extension. The suffix, or letters following the period in a file name, which identify the type of file named.

firewall. Software or hardware that protects a computer or a private network of computers from other computers on the Internet.

firewire. A fast, high-capacity port on a computer for transferring large amounts of data, such as video footage from a digital camcorder.

flash memory. Rewriteable memory, such as the memory chips that hold digital photos, that keeps its data even when power is turned off.

format. The particular manner in which data is stored.

freeware. Software that is not copyrighted and can be used and copied by anyone.

general-purpose computers. Computers that can be programmed to perform a number of different jobs. Personal computers are general-purpose computers.

gigabyte (GB). One billion bytes or one thousand megabytes.

grayscale. How black and white images are represented on a computer screen, in individual pixels, that give images the appearance of having different shades of gray.

hard drive. A rigid disk consisting of several platters that store information in magnetic form, usually installed inside a computer.

HTML (hypertext markup language). The basic language for displaying text and pictures on Web sites and linking different Web pages together.

icon. A picture on the computer screen that represents a program or a file.

impact printer. A printer that strikes the paper through an inked ribbon to produce characters on the page.

Ink-jet printer. A printer that sprays ink onto a page to produce characters.

input device. A device by which data can be entered into a computer.

integrated circuit. A group of related circuits all manufactured together in a single chip.

intellectual property. Ideas and expressions of the human mind considered unique and original and to be worth money in the marketplace—and deserving of protection under the law.

Internet. A worldwide system of computer networks.

Internet protocol (IP) address. The address of a computer on the Internet. Every computer connected to the Internet has an IP address, either a permanent one or a different one that is assigned to the computer each time it connects.

kilobyte (KB, or K). A little more than a thousand bytes of information—1,024, to be exact.

laser printer. A printer that uses a laser beam to produce characters on the page.

local area network. A computer network within a single office, building, or other site.

low-level, or machine, code. A language made up of sets of binary codes that a computer uses to process information.

magnetic memory. A means of storing data using magnetic particles, such as on a diskette, hard drive, or recording tape.

mainframe. A large computer accessed by many users.

megabyte (MB). One million bytes.

memory. Where a computer stores information, for example, in RAM or ROM, or on compact discs or hard drives.

microcomputer. A personal computer.

microprocessor. The "brain" of a microcomputer.

minicomputer. A midsized computer.

modem. A device used by computers to communicate over telephone lines or television cables.

monitor. A computer screen.

motherboard. The main circuit board of a computer that normally contains the central processing unit.

mouse. A movable device used to point to different locations on the screen and send signals to the computer.

network. A group of connected computers.

object code. Instructions for the computer that have been converted from English-like instructions (high-level code) into machine code (low-level code).

operating system. Software that allows the computer to perform basic functions.

optical storage. Technology that uses lasers to sort and retrieve information.

output device. Any device such as a monitor, printer, or sound card that allows you to send out information from a computer.

peripheral. An attachment to a computer, such as a printer or a mouse.

personal computer (PC). A small computer with software oriented toward easy, single-user applications. Often used to distinguish a microcomputer running a Windows® operating system, as opposed to a Macintosh®.

personal digital assistant. A handheld computer, commonly called a *PDA*, that can provide a range of basic computing functions.

piracy. Illegal copying, selling, or giving away of intellectual property.

pixel. Short for *picture element;* a single dot on a computer screen.

plotter. A printer that uses pens to draw on a page.

printer. A device used to print out information (usually on paper) stored in a computer.

program. A set of computer instructions.

programming language. The language used by a programmer to write instructions that a computer can understand or interpret.

protocol. The rules computers use to communicate with each other.

punched card. A paper card punched with hole patterns that was used to load information into early computers.

RAM (random-access memory). Temporary memory that the computer uses to store programs and information until the computer is turned off.

read. To retrieve information or a program from storage and put it into the computer's internal memory. The opposite of *write.*

relay. An electromagnetic switch used to complete electrical circuits.

resolution. Describes in how much detail an image is printed (in dots per inch, or DPI) or displayed on the computer monitor (in number of pixels wide by number of pixels high).

ROM (read-only memory). Permanent, unchangeable memory used to store basic instructions the computer needs in order to operate.

router. A device or software that serves as a bridge between two or more networks. A router determines the best route for sending a packet of data to its destination.

scanner. A device that changes a picture into digital information.

search engine. On the World Wide Web, a set of programs that seeks out information you request and presents you with an index of Web sites containing the information.

sector. An area on a disk where information is stored.

semiconductor. A material, such as silicon, that can both conduct electricity and resist it.

sensor. A device used to convert physical information such as temperature, light, or electric current into data meaningful to a computer.

server. A computer on a network that manages shared resources, such as files or Web pages.

shareware. Software that you pay for after you have tried it and decided to use it.

software. Any computer program.

sound digitizer. A device that converts sound into digital form.

sound card. A set of chips on a board that includes a digitizer and allows a computer to produce or record sound.

source code. A program in a language prepared by a programmer and that must be compiled into object code for a computer to understand it.

special-purpose computer. A computer designed for a specific purpose, such as controlling the antilock brakes of an automobile.

spreadsheet program. A program used to help solve math-oriented problems such as budgets.

supercomputer. The fastest type of computer made.

tape drive. A storage mechanism that uses tape cartridges instead of disks.

thermal printer. A printer that uses special heat-sensitive paper to produce an image.

tracks. A series of circles on a disk, like the rings of a bull's-eye, that store information.

transistor. A device that can both conduct an electrical current and resist it, functioning as a switch.

true color. The effect of the maximum amount of colors that can be produced by pixels.

Wi-Fi (wireless fidelity). A method of connecting computers on a network with radio signals rather than wires.

workstation. A networked computer, typically more powerful than a personal computer.

World Wide Web. The collection of all the resources and users on the Internet that can be accessed with a Web browser.

write. To store information or a program. The opposite of *read.*

Computer Resources

Books

Ceruzzi, Paul E. *A History of Modern Computing.* MIT Press, 2003.

Gookin, Dan. *Buying a Computer for Dummies, 2004 ed.* Wiley, John & Sons Inc., 2004.

Kent, Steven. *The Ultimate History of Video Games: From Pong to Pokemon.* Prima Lifestyles, 2001.

McGinty, Alice B. *Software Designer.* Rosen Publishing Group Inc., 2000.

Miller, Michael. *Absolute Beginner's Guide to Computer Basics.* Que, 2002.

Reid, T. R. *The Chip: How Two Americans Invented the Microchip and Launched a Revolution.* Random House, 2001.

Rothman, Kevin F. *Coping With Dangers on the Internet.* Rosen Publishing Group Inc., 2000.

Sethi, Maneesh. *Game Programming for Teens.* Premier Press, 2003.

Stair, Lila B., and Leslie Stair. *Careers in Computers, 3rd ed.* McGraw-Hill Companies, 2002.

White, Ron. *How Computers Work, 7th ed.* Que, 2003.

Magazines

Game Developer Magazine
CMP Media LLC
600 Community Drive
Manhasset, NY 11030
Telephone: 516-562-5000
Web site: *http://www.gdmag.com*

MacAddict
Future Network USA
150 N. Hill Drive
Brisbane, CA 94005
Telephone: 415-468-4684
Web site: *http://www.macaddict.com*

Macworld
Mac Publishing
501 Second St.
San Francisco, CA 94107
Telephone: 417-243-0505
Web site: *http://www.macworld.com*

PC Magazine
Ziff-Davis Media
28 E. 28th St.
New York, NY 10016
Telephone: 212-503-3500
Web site: *http://www.pcmag.com*

PC World
PC World Communications Inc.
501 Second St.
San Francisco, CA 94107
Telephone: 415-243-0500
Web site: *http://www.pcworld.com*

Organizations and Web Sites

American Society for Engineering Education
1818 N St. NW, Suite 600
Washington, DC 20036-2479
Telephone: 202-331-3500
Web site: *http://www.asee.org, http://www.engineeringk12.org*

The Computer History Museum
1401 N. Shoreline Blvd.
Mountain View, CA 94043
Telephone: 650-810-1010
Web site:
http://www.computerhistory.org

The Computer Society
1730 Massachusetts Ave. NW
Washington, DC 20036-1992
Telephone: 202-371-0101
Web site: *http://www.computer.org*

Entertainment Software Association
1211 Connecticut Ave. NW, Suite 600
Washington, DC 20036
Web site: *http://www.theesa.com*

Institute of Electrical and Electronics Engineers
3 Park Ave., 17th Floor
New York, NY 10016-5997
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