**Computer.** Computer once meant a person who did computations, but now the term almost universally refers to automated electronic machinery.

**Computing Basics**

The first computers were used primarily for numerical calculations. However, as any information can be numerically encoded, people soon realized that computers are capable of general-purpose information processing. Their capacity to handle large amounts of data has extended the range and accuracy of weather forecasting. Their speed has allowed them to make decisions about routing telephone connections through a network and to control mechanical systems such as automobiles, nuclear reactors, and robotic surgical tools. They are also cheap enough to be embedded in everyday appliances and to make clothes dryers and rice cookers “smart.” Computers have allowed us to pose and answer questions that could not be pursued before. These questions might be about DNA sequences in genes, patterns of activity in a consumer market, or all the uses of a word in texts that have been stored in a database. Increasingly, computers can also learn and adapt as they operate.

Computers also have limitations, some of which are theoretical. For example, there are undecidable propositions whose truth cannot be determined within a given set of rules, such as the logical structure of a computer. Because no universal algorithmic method can exist to identify such propositions, a computer asked to obtain the truth of such a proposition will (unless forcibly interrupted) continue indefinitely—a condition known as the “halting problem.” Other limitations reflect current technology. Human minds are skilled at recognizing spatial patterns—easily distinguishing among human faces, for instance—but this is a difficult task for computers, which must process information sequentially, rather than grasping details overall at a glance. Another problematic area for computers involves natural language interactions. Because so much common knowledge and contextual information is assumed in ordinary human communication, researchers have yet to solve the problem of providing relevant information to general-purpose natural language programs.

**Analog computers**

Analog computers use continuous physical magnitudes to represent quantitative information. At first they represented quantities with mechanical components (see differential analyzer and integrator), but after World War II voltages were used; by the 1960s digital computers had largely replaced them. Nonetheless, analog computers, and some hybrid digital-analog systems, continued to be in use through the 1960s, in tasks such as aircraft and spaceflight simulation.

One advantage of analog computation is that it may be relatively simple to design and build an analog computer to solve a single problem. Another advantage is that analog computers can frequently represent and solve a problem in “real time”; that is, the computation proceeds at the same rate as the system being modeled by it. Their main disadvantages are that analog representations are limited in precision—typically a few decimal places but fewer in complex mechanisms—and general-purpose devices are expensive and not easily programmed.

**Digital** **computers**

In contrast to analog computers, digital computers represent information in discrete form, generally as sequences of 0s and 1s (binary digits, or bits). The modern era of digital computers began in the late 1930s and early 1940s in the United States, Britain, and Germany. The first devices used switches operated by electromagnets (relays). Their programs were stored on punched paper tape or cards, and they had limited internal data storage. For historical developments, see the section Invention of the modern computer.

**Mainframe** **computer**

These computers came to be called mainframes, though the term did not become common until smaller computers were built. Mainframe computers were characterized by having (for their time) large storage capabilities, fast components, and powerful computational abilities. They were highly reliable, and, because they frequently served vital needs in an organization, they were sometimes designed with redundant components that let them survive partial failures. Because they were complex systems, they were operated by a staff of systems programmers, who alone had access to the computer. Other users submitted “batch jobs” to be run one at a time on the mainframe.

Such systems remain important today, though they are no longer the sole, or even primary, central computing resource of an organization, which will typically have hundreds or thousands of personal computers (PCs). Mainframes now provide high-capacity data storage for Internet servers, or, through time-sharing techniques, they allow hundreds or thousands of users to run programs simultaneously. Because of their current roles, these computers are now called servers rather than mainframes.

**Supercomputer**

The most powerful computers of the day have typically been called supercomputers. They have historically been very expensive and their use limited to high-priority computations for government-sponsored research, such as nuclear simulations and weather modeling. Today many of the computational techniques of early supercomputers are in common use in PCs. On the other hand, the design of costly, special-purpose processors for supercomputers has been supplanted by the use of large arrays of commodity processors (from several dozen to over 8,000) operating in parallel over a high-speed communications network.

**Minicomputer**

Although minicomputers date to the early 1950s, the term was introduced in the mid-1960s. Relatively small and inexpensive, minicomputers were typically used in a single department of an organization and often dedicated to one task or shared by a small group. Minicomputers generally had limited computational power, but they had excellent compatibility with various laboratory and industrial devices for collecting and inputting data.

**Microcomputer**

A microcomputer is a small computer built around a microprocessor integrated circuit, or chip. Whereas the early minicomputers replaced vacuum tubes with discrete transistors, microcomputers (and later minicomputers as well) used microprocessors that integrated thousands or millions of transistors on a single chip. In 1971 the Intel Corporation produced the first microprocessor, the Intel 4004, which was powerful enough to function as a computer although it was produced for use in a Japanese-made calculator. In 1975 the first personal computer, the Altair, used a successor chip, the Intel 8080 microprocessor. Like minicomputers, early microcomputers had relatively limited storage and data-handling capabilities, but these have grown as storage technology has improved alongside processing power.

In the 1980s it was common to distinguish between microprocessor-based scientific workstations and personal computers. The former used the most powerful microprocessors available and had high-performance colour graphics capabilities costing thousands of dollars. They were used by scientists for computation and data visualization and by engineers for computer-aided engineering. Today the distinction between workstation and PC has virtually vanished, with PCs having the power and display capability of workstations.

**Embedded** **processors**

Another class of computer is the embedded processor. These are small computers that use simple microprocessors to control electrical and mechanical functions. They generally do not have to do elaborate computations or be extremely fast, nor do they have to have great “input-output” capability, and so they can be inexpensive. Embedded processors help to control aircraft and industrial automation, and they are common in automobiles and in both large and small household appliances. One particular type, the digital signal processor (DSP), has become as prevalent as the microprocessor. DSPs are used in wireless telephones, digital telephone and cable modems, and some stereo equipment.