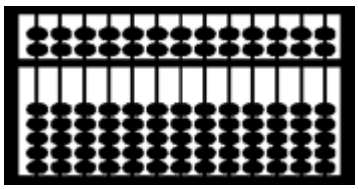
The Journey Inside[SM]: Introduction to Computers
Background Information, Part 1

History of Computers

Today's computers have the ability to process, store, and share large quantities of information. They were preceded by a wide variety of inventions attempting to do similar tasks. Some succeeded better than others.

Information Processing

Today's computers are responsible for a great deal of the world's information processing and sharing. A long history leads to this modern era of desktop computers. Centuries ago, people used knotted string and piles of pebbles to help them count. The abacus is a simple but powerful aid to counting and computation and has survived for thousands of years. It is still in use.



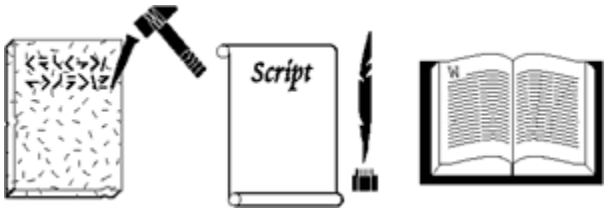
During the last century, a number of mechanical calculators, such as that developed by Blaise Pascal, were invented. In the mid-1800s, Charles Babbage developed plans for a device he called the analytical engine. Although his device was never completed, the analytical engine was designed to use gears and steam to process and store information. It was a true predecessor to today's computer.

The field of electronics has generated many new ideas for devices to process information. Electronic components work faster and more efficiently than mechanical devices. The vacuum tube provides an on/off switch that is much more efficient than mechanical switches had been. Using vacuum tubes, the first truly electronic-based computer was created. The electrical numerical integrator and calculator—the ENIAC—used 18,000 of these switches.

The computers your students use bear little resemblance to ENIAC or Babbage's Analytic Engine. The computers they use are fast, small, and powerful. The software and hardware available to students combines to provide machines capable of doing many different tasks in amazingly short periods of time. The computer, which was first perceived as an aid to calculation, has quickly become an aid to communication.

Information Storage

To communicate with one another, early humans developed complex oral languages. A spoken language, while an effective system for sharing ideas, is limited in application. People have to be within hearing distance of each other to communicate. The creation of a symbolic or written language removed this limitation. Information could now be stored. Once ideas could be put into written form, people could communicate across distances. A progression of inventions evolved to assist people with information storage. Clay tablets, scrolls, books, and the printing press are all part of this evolution.



Information storage is important in the history of computing, and the Jacquard loom that stored fabric patterns on punched cards provided a crucial step. The punch card storage idea was adopted by Herman Hollerith for the 1890 U.S. Census. Hollerith's invention led to the modern punch card which was used for information storage on the computers that existed in the 1960s and 1970s.

People now use a wide range of information storage devices, such as books, audiotapes, videotapes, still photos, and computer-based technology, to store and disseminate information. Storage of information using a computer consists of two different types of memory—long-term and temporary. Long-term storage is necessary to keep information. Hard drives, CD-ROMs, floppy disks, and magnetic optical disks are examples of long-term storage devices.

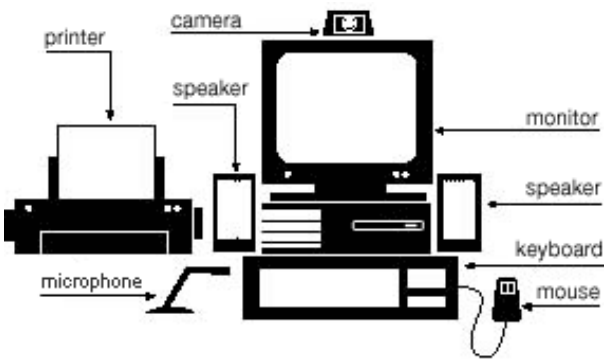
During the processing of information by computers, some information storage is temporary, but equally important. Special integrated circuits called memory chips are often dedicated to the task of temporary storage of data. The technology used by today's computers for information storage is more flexible and has more capacity than any earlier form of information storage.

The Journey Inside[SM]: Introduction to Computers
Background Information, Part 2

Information Processing Machines

In addition to being able to store and process information, a computer must have a way to input and output information.

A complete computer system can be thought of in terms of four different components—input, storage, processing, and output. When all the components work together, a computer provides a tremendous tool for completing a wide range of tasks.



To enable the four components to interact with each other, computer manufacturers use a special circuit board called a motherboard. The motherboard of a personal computer contains the pathways for data to be sent from one component to another, sockets to hold many of the parts, the microprocessor (the main processing unit), and many supporting chips. When you look at a motherboard, it is possible to see some of the components used to process and store information. To increase the versatility of a computer, the motherboard also provides a way to include other special controllers such as sound cards. These may be installed directly onto the motherboard or connected via a special expansion slot or socket designed to connect the motherboard's circuits with the circuits on the special controller board.

Whatever form the information takes—text, graphics, sound, music, or video—it must be translated into a digital format so the computer can process and store it. Digital information, information that is represented in numerical form, is represented in the computer as a series of 1s and 0s. Using the binary system, a switch that is "on" can represent a 1; the same switch in an "off" position can represent a zero.

The vacuum tube, the central component of the earliest computers, functioned as an "on/off" switch. Transistors, smaller and more reliable than vacuum tubes, gradually replaced vacuum tubes as switches in computers. Eventually, transistors became so small that millions of them could be put on a small silicon chip, called an integrated circuit. These circuits process and store information in every modern computer.

The computer, a multipurpose machine, uses many integrated circuits. Central to the actions in the computer is the special integrated circuit called the microprocessor. The microprocessor is designed to allow the combination of software and hardware to change. Because the instruction sets understood by the microprocessor can be changed, a computer can handle a variety of tasks: word processing, creating and displaying graphics, playing music, and more. The final choice of application is left to the user, not the designers of the computer.

Information Sharing

Every generation has found a way to share information with others. Oral communication is limited in the sharing of information to face-to-face situations or through the use of the telephone. Such exchanges require both giver and receiver be in the same place at the same time, or for both to have access to telephones to overcome the challenge of distance. Once written languages developed, exchanging information became easier. Writing lets people share information regardless of time passing or the distance between giver and receiver. Despite the advantages, written communication does have limitations. It takes time to record and exchange information.

Computers have caused tremendous changes in the exchanging of information. Time and distance are no longer factors in sharing information. Using the ever-growing number of computer networks, there is little difference between sending a written message across the world or sending the same message across the street. In addition, computer networks are providing access to more and more stored information. Information can be exchanged at the convenience and choice of the giver and the receiver. Computers have evolved to provide us with an extremely versatile communication device.

The Journey Inside[SM]: Introduction to Computers
Background Information, Part 3

General Purpose Computers

Computers require four components—input, storage, information processing, and output — to operate. People interact with information expressed in a variety of forms. Text, sounds, color, pictures, and movements are all forms of information that people can understand and share. Computers have evolved to the point where people can communicate with their computers using these same kinds of information. The computer communicates back to the user using these same information formats. However, for its own use, the computer translates everything into binary information.

Computer Storage

Your computer is capable of handling incredible amounts of information in an extremely short time. Facilitating this speed has meant creating efficient storage and retrieval options.

Hard disks (hard drives), floppy disks, CD-ROMs, and tapes all provide long-term storage. These are excellent storage devices but are limited to a relatively slow retrieval rate. This lack of speed makes them unsuitable storage devices for holding information the computer is processing. The microprocessor can handle information much faster than it can be retrieved from external storage.

Special integrated circuits are created to handle the information that is used while the computer is actually working. Special read only memory (ROM) chips provide permanent primary memory to hold all the start-up programs needed to prepare the computer for use. This storage is unaffected when the computer is turned off. This type of memory is filled with data during the manufacture of the computer.

Random access memory (RAM) or temporary primary memory, is used to temporarily hold the programs, instructions, and information needed for a given work session. This type of memory is given information to store each time the computer is started. The contents of this type of memory may change many times during one work session. Data on RAM chips can be retrieved in about 120 billionths of a second. However, each time the computer is shut down, information in this kind of memory is no longer available. When the computer is restarted, the information you need is loaded into RAM.

Some computers also have cache memory, a special type of RAM. This type of memory can be more than 10 times faster than the main memory RAM chips but is much more expensive. The computer uses cache memory to hold the operating instructions or data that may be needed in the immediate future. Cache memory is very helpful in keeping the computer operating at top speed.

Special Purpose Computers

The same technology that is used in today's general purpose computers is used in a wide variety of other devices. These special purpose computers are designed to make our lives easier and more comfortable. Our VCRs, digital cameras, microwave ovens, and answering machines all use special purpose computers for operation.

Most special purpose computers contain dedicated integrated circuits called embedded processors. The user cannot change the function of the special purpose computer or embedded processor. Rather, embedded processors are preprogrammed to perform only

specific functions. For example, your VCR may have an embedded processor that has been given the instructions that allow you to control the interaction of the VCR and television set in complex ways. However, you can only use the instructions that are already built in. You are not able to modify or change the features in any way.

Resources

The first three resources are annotated and are appropriate for both teachers and students:

Freed, L. (1995). *The History of Computers*. Emeryville, CA: Ziff-Davis Press.
A well-selected collection of photos and illustrations providing a chronological introduction to how, why, and when the computer became part of our lives.

Malone, M. (1995). *The Microprocessor: A Biography*. Santa Clara, CA: Springer-Verlag.
A very readable history of the invention of the microprocessor that provides a rare glimpse of the people instrumental in making the microprocessor business so successful. This is suitable for older students and teachers.

Gau, J. & Segalla, S. (Producers). (1996). *Triumph of the Nerds* [videotape]. New York: Oregon Public Broadcasting and John Gau Productions.
This three-tape set shares many insightful and personal stories from people instrumental in the development of the personal computer and a discussion of where they think the next steps might take us.

How Computers Work. (1993). [CD, Macintosh]. Warner New Media.

Flaherty, T. (Ed.). (1989). *Illustrated Chronology and Index*. Richmond, VA: Time-Life Books.

"Inventing and Writing Numbers." In Bunch, B., & Hellemans, A. (1993). *The Timetables of Technology: A Chronology of the Most Important People and Events in the History of Technology*. New York: Simon and Schuster

How Multimedia Computers Work. (1994). [CD, Windows]. Mindscape, Inc.

Ronan, C. (Ed.). (1994). *Science Explained* (pp. 214-223). New York: Holt.

Suplee, C. (1996). *Everyday Science Explained* (pp. 90-99). Washington, DC: National Geographic.