An Introduction to Computers

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Introduction

Computers provide one of the most influential forces available in modern times. Harnessing the power of computers enables our relatively limited and fallible human capacities for memory, logical decision making, reaction and perfection to be extended to almost infinite levels. Millions of complex calculations can be done in mere fractions of the time needed to be performed by a human. Difficult decisions can be made with unerring accuracy for comparatively little cost. Indeed, historians will probably look back on the present era as representing the "information revolution."

The Evolution of the Computer

Having the right tools to perform a task has always been important for human beings. In earlier times, when the task was simply counting or adding, people used either their fingers or pebbles, especially when counting quantities greater than ten. People placed the pebbles along lines in the sand. In order to have the sand and pebbles handy all the time, Phoenicians built a box and kept the counting devices in there. The box was called an ***Aback***. Later on the Romans called it an ***Abacus***. The Chinese abacus consisted of beads instead of stones.

Strung on wires, these beads made the abacus easier to use and to carry around. The abacus was simple and was used worldwide for centuries. In fact, it is still used in many countries today.

In the eighth century, Hindu-Arabic numerals were introduced in India and Arabic countries. Calculating with Hindu-Arabic numerals was so much faster and easier that their use soon spread to Europe. The basic numbers were 0 - 9 used in base ten, the system we still use today.

During the fourteenth and fifteenth centuries wheels and gears were being used in clocks and music boxes. In 1642, Blaise Pascal, a nineteen-year-old Frenchman, combined the Arabic numerals concept with the wheels and gears technology to build a calculating machine called the ***Pascaline***. This calculating machine had the ability to add and subtract ones, tens, hundreds, thousands, and so on. Though the Pascaline was originally intended to benefit only Blaise Pascal's father, a tax collector, Pascal eventually sold over fifty of his calculating machines.

For the next two centuries, the basic idea of the Pascaline became perfected to the point that Gottfried Leibniz, a mathematician, invented a calculating machine which was able to do multiplication. One problem remained, however. Parts had to be made by hand and did not always fit together perfectly. As a result, the machine often made mistakes.

In the 1840s, Charles Babbage, an English mathematician, developed an idea for a machine called an ***Analytical Engine*** which would be controlled by punched cards. The Analytical Engine would do addition, subtraction, multiplication, and division automatically. The machine, powered by steam, would be able to do one addition problem per second as well as store numbers and answers on another punched card. The Analytical Engine was never finished.

The tabulation of the 1880 census took about seven years to complete. It was estimated that with population growth, tabulation of the 1890 census would take about twenty years to complete. To solve this perplexing problem, an American named Herman Hollerith, who worked for the Census Bureau, invented a new electrical machine that could add, subtract, and sort census information. He called it the ***Data Tabulator***.

The new machine used the punch card system to enter data. For each question there was a punch in the card. The punched cards were fed into the card reader of the Data Tabulator. The card reader dropped rows of pins onto the card. The pins that went through the punched holes made electrical contact. The results were processed and then recorded on a dial. Each dial corresponded to a specific total, e.g., number of people in each household, number of males, and so on. Hollerith's machine worked so efficiently that the tabulation of the 1890 census took only three years, instead of twenty, saving the government five million dollars.

It was not long before businesses realized that the Data Tabulator could save money as well as speed up data processing procedures. Several companies began producing the Data Tabulator. Herman Hollerith founded a company which later became the International Business Machines (IBM) Corporation.

By the 1930s, calculators were used to solve mathematical problems. The problem with these calculators was that they could solve only one problem at a time. The market was looking for a device that would be able to do arithmetic operations and mathematical problem solving simultaneously.

In 1937, a Harvard University professor named Howard Aiken proposed such a device. In 1944, with the help of engineers from IBM, he completed the Harvard-IBM joint project and built the first working computer called ***Mark I***. This first computer weighed more than five tons and was constructed with parts from seventy-eight electrical accounting machines, all strung together with five hundred miles of wire. The Mark I was comprised of three units: the ***Arithmetic and Logic Unit (ALU)***, for performing arithmetic operations, the ***Memory Unit***, for storing numbers, and the ***Control Unit***, for coordinating the functions of the other two units. This machine could perform three additions per second using mechanical relay switches to send the data over the miles of wires.

In 1945, the ***first generation*** computer using a ***binary*** system, called ***ENIAC*** (Electronic Numeric Integrated and Calculator), was built at the University of Pennsylvania. It used ***vacuum tubes.*** ENIAC was the first electronic computer and was one thousand times faster than Mark I. It weighed 30 tons, used more than 18,000 vacuum tubes, occupied 3,000 cubic feet, and had only 12K memory (equivalent to 12,000 characters). Vacuum tubes consumed a large amount of electricity, produced large amounts of heat, and were relatively unreliable.

A binary, or base two, system has two states, on or off. A vacuum tube or any kind of electronic switch has only two states which are symbolized by 0 for off and 1 for on. In computer terminology each 0 or 1 is called a ***bit*** and a combination of eight bits is a ***byte***. Each byte represents a character whether alphabetical, numerical, or symbolic. The programs for binary computers have to be written with binary numbers, which is called ***machine language***. In the beginning, all programs were written in machine language. A ***program*** is a set of instructions written to describe a specific task for the computer to perform.

The computer's existing memory was not sufficient to run any programs. In 1946, the ***auxiliary memory*** was developed in order to store data. The most popular and widely used memory media were magnetic tapes and disks. Information was stored on the auxiliary memory magnetically and could be retrieved later on.

In the late 1950s, ***transistors*** were introduced into the market and were used instead of vacuum tubes in items such as radios and television sets. New, ***second generation*** computers used transistors, or solid-state circuitry, and became much smaller, faster, more reliable, and inexpensive. The IBM 1401 in 1960 was the first computer to use this new technology.

In the late 1960s, a technological breakthrough came about when the ***integrated circuit (IC)*** began to be used in electronics. This led to the creation of the ***third generation*** of computers. Integrated circuits were a combination of a thousand or more circuits built on a small piece of silicon called the ***chip***. The integrated circuits were smaller, more efficient, and reliable. Unlike the transistors that were assembled manually, ICs could be manufactured. This method of production resulted in a lower cost. In 1965, the IBM 360 was introduced as a general-purpose computer, rather than as a computer designated primarily for either business or scientific use.

In the early 1970s, ***large-scale integration (LSI)*** began to change computer technology. LSI placed several thousand transistors onto a single chip. As a result, a ***fourth generation*** computer was introduced to the market. This advancement was followed in the mid 1970s by the development of ***very large-scale integration (VLSI)***, the incorporation of several hundred thousand transistors onto a chip. VLSI led Intel Corporation to the development of the ***microprocessor*** chip which in turn resulted in the creation of the microcomputer**.**

Only a few microcomputers with limited capabilities and customer support were available until 1978 when Steve Jobs and Steve Wozniak developed the first Apple computer. They worked in a garage with a capital of only $2,500. Their company has grown to a multi-billion-dollar corporation, targeting primarily schools and colleges, with computers available to the business world as well. The IBM PC (Personal Computer), introduced in 1981, encouraged widespread use of microcomputers in the business world.

The dream of creating a human-like computer that would be capable of deductive reasoning and reaching a decision through a series of “what-if-then” analyses has existed since the beginning of computer technology. Such a computer would learn from its mistakes and possess the skill of experts. These are the objectives for creating the ***fifth generation*** of computers.

The starting point for the fifth generation of computers has been set for the early 1990s. However, the ***expert system*** concept is already in use. The expert system is defined as a computer information system that attempts to mimic the thought process and reasoning of experts in specific areas. Four characteristics can be identified with fifth generation computers. These are:

- Mega-chip memory
- Parallel processing
- ***Natural language processing***
- Artificial intelligence

A ***mega chip*** is a chip with over a million bytes of storage capacity. In order to store instructions and information, fifth generation computers require a great amount of storage capacity. Mega- chips may enable the computer to approximate the memory capacity of the human mind.

Most computers today access and execute only one instruction at a time. This is called ***serial processing***. However, a computer using ***parallel processing*** accesses several instructions at once and works on them at the same time through use of multiple central processing units.

Natural language processing (NLP) is the ability of a computer to understand and respond to commands that are given in a natural language, such as English. At the present time, there is no fully workable NLP dialogue on the market, yet researchers are in the process of attempting to combine NLP with voice and vision recognition.

Artificial intelligence (AI) refers to a series of related technologies that tries to simulate and reproduce human behavior, including thinking, speaking and reasoning. AI is comprised of a group of related technologies: expert systems (ES), natural language processing (NLP), speech recognition, vision recognition, and robotics.

New Literacy

Computers are now an important aspect of education. Some nationwide publications have targeted the use of computers in education. Newspapers and magazines regularly contain stories about teachers placing computers in classrooms. Students are using computers more than ever. Special-education programs use computers extensively for remedial purposes. Numerous federal and state grants are devoted to research on computers in education.

Almost everybody agrees that computer literacy is necessary for survival in today's technological society. However, computer literacy goes beyond demonstrating proficiency in the "three Rs" (reading, writing, and arithmetic). What is the definition of computer literacy? Who is considered computer-literate? How can we prepare students to become computer-literate individuals?

Computer literacy is the knowledge and skill required to use computers as productive tools. It emphasizes two major points: ***computer awareness*** and the ***ability to operate a computer***. Computer awareness deals with the basic knowledge about computer components and uses. It includes an understanding of how computers can affect society, solve educational problems, and enhance the teaching/learning process. The computer-literate student should understand the capabilities of a computer and attain the skills necessary to use a computer to accomplish a variety of tasks, such as word processing, use of a database, spreadsheet, data communications, programming, and so on.

The concentration in educational computing should be on both aspects of computer literacy yet teachers, administrators, and legislators prefer different facets of computer literacy. Some deny the benefit of programming. Others are attempting to require a computer literacy course as a requirement for high school graduates. Training teachers to be computer-literate themselves is the key requirement in promoting computer literacy.

Computer System Components

There are several computer systems on the market with a wide variety of makes, models, and peripherals. In general, a computer system is comprised of input devices, a central processing unit (CPU), output devices, and memory. Figure 1 illustrates the computer system components.

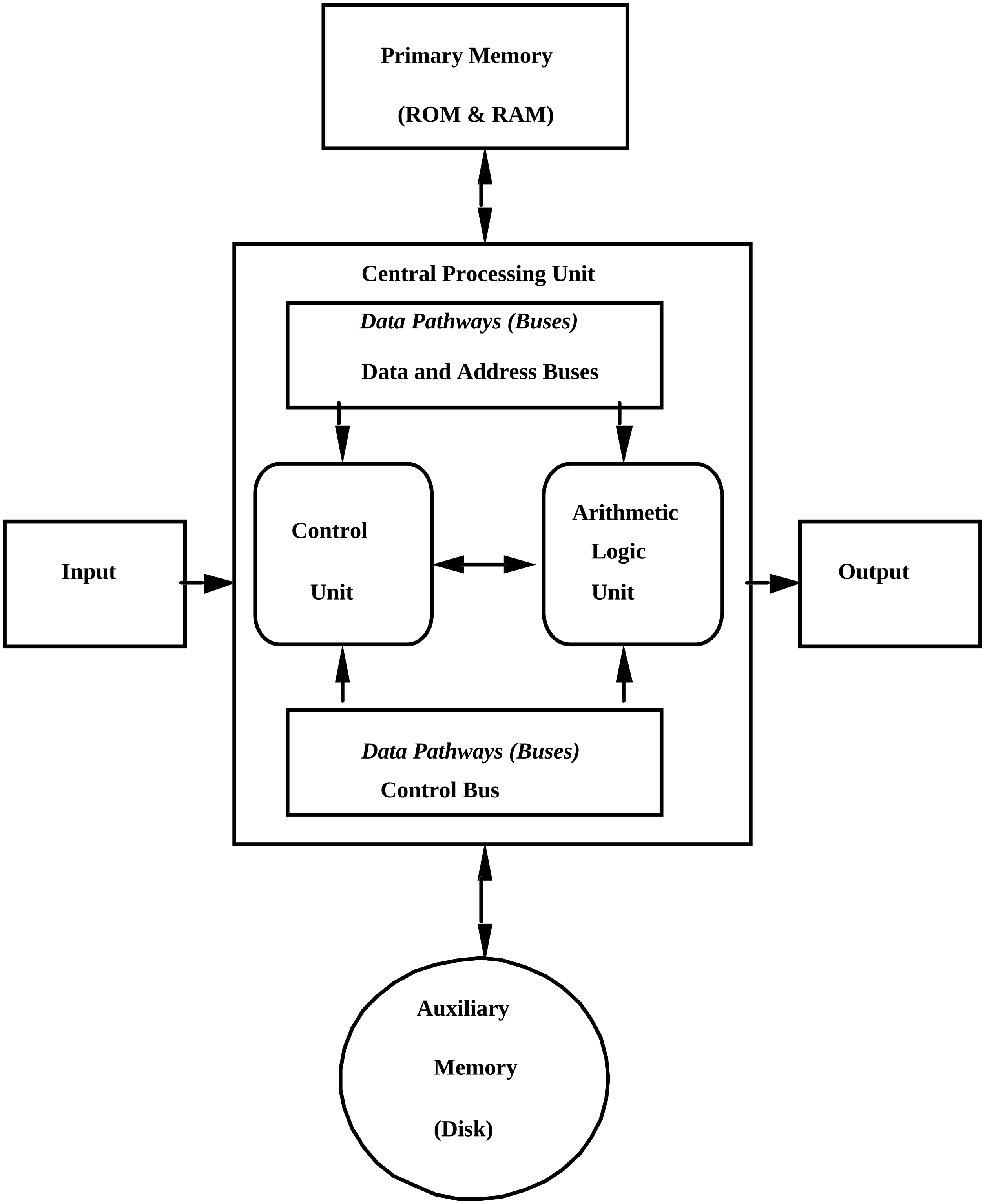


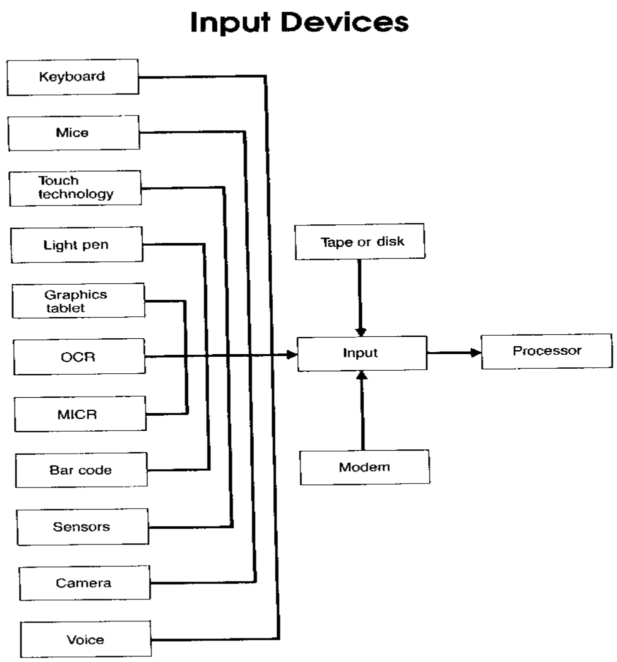
Figure 1. Computer system components. The relationship between different components of computer systems is shown here. Arrows indicate the basic movement of data or instruction among these elements.

Input Devices

Data must be entered into the computer through input devices where information is then converted into electrical signals and sent to the central processing unit. For example, if you press the letter A on the computer keyboard, the keystroke is encoded, or converted into machine language, and then stored in the memory for later processing. The keyboard, mouse, light pen, graphics tablet, bar code, sensor, scanner, disk, tape, and modem are some examples of the most commonly-used input devices.

Central Processing Unit (CPU)

The central processing unit (CPU) is the part of a computer that executes the instructions or programs. Two kinds of processing used today are



batch processing and ***real time processing***. Batch processing means that the computer does not start processing the new program until it has finished the previous program. With this method, computer users have to wait hours, even days, for their program to run on the computer. As a result, information is only as current as the last processing. Real time processing processes programs or instructions immediately after they have been entered into the system and the information is current.

The CPU is comprised of three parts:

- Arithmetic and logic unit (ALU)
- Control unit
- Primary memory

The ***ALU*** consists of the arithmetic unit and the logic unit. The function of the arithmetic unit is to execute basic operations such as addition, subtraction, multiplication, and division. The arithmetic unit can also provide logarithmic, trigonometric, and other mathematical functions by combining the basic arithmetic operations. The logic unit makes comparisons and takes action based on the results. In this unit, numbers and conditions are compared. Greater than, less than, equal to, not equal to, and, or, and not are some examples of logic functions.

The ***Control Unit*** coordinates and supervises the function of the entire computer system. When data enters the computer through an input device, the control unit directs it to the primary storage. The control unit then fetches the data from the primary memory and, according to the receiving order, decodes or interprets it and sends it to the ALU for execution. Finally, the control unit directs the results to the output device or auxiliary memory. The control unit functions more or less like a traffic controller that supervises the movement and execution of data.

The control unit synchronizes the CPU tasks by using a ***system clock*** which releases timely electrical pulses. The time required to get data from the primary memory and interpret it is called ***instruction time (I-time)*** and time required to execute data is called ***execution time (E-time).*** The clock speed is measured in megahertz (MHz). One hertz is the completed cycle in a second, a megahertz being equal to one million cycles per second. Today, microprocessors have different execution speeds. Under equal conditions, a 16-MHz processor will be twice as fast as an 8-MHz processor.

Data and instruction are stored temporarily in the ***primary memory*** or primary storage unit. This part of the memory is called ***random access memory (RAM).*** The primary memory also includes another kind of memory which is permanent and contains instructions that tell the computer what to do once it is turned on. This is called the ***read only memory (ROM)***. The instructions in ROM are written in the factory and cannot be altered by the user. The primary memory will be discussed in detail later on in this chapter.

In the CPU, data is transferred through an electronic pathway to different points in the CPU's circuits. This pathway is called a ***bus***. There are three kinds of buses: a ***control bus,*** an ***address bus*** and a ***data bus***. A control bus is the pathway for all timing and controlling functions sent by the control unit to the other units in the system. The address bus is the pathway that locates the storage position in the memory for the data to be found or executed. Finally, the data bus is the pathway that carries data from the input devices to the CPU and from the CPU to the output devices.

Another part of the CPU is the ***register***, which contains instructions or data that are to be acted upon immediately, and holds only one piece of data at a time. The size and number of registers determine the speed of the computer. The number of bits that can be stored and manipulated as a unit is called a ***word***. Word size or word length refers to the number of bits forming a word. Today, word length varies from 8 to 128 bits. When a computer has a word length of 16 bits, the processor is a 16-bit processor.

Output Devices

The processing of data is completed when a computer shows the results. The results are called ***output.***There are four major kinds of output:

- ***Text***, consisting of words, numbers and symbols.
- ***Image***, which is in the form of graphics or pictures.
- ***Sound***, either music or voice.
- ***Machine-readable data***, which are codes that other comput-ers can read.

Many output devices are available on the market. ***Printers*** and ***display monitors*** are the most frequently used. Printers offer a variety of choices:

- ***Dot-matrix printers*** print dots in the shape of characters.

- ***Letter-quality printers*** print typewriter quality output.

- ***Laser printers*** create output with laser beams, resulting in a high quality printing.

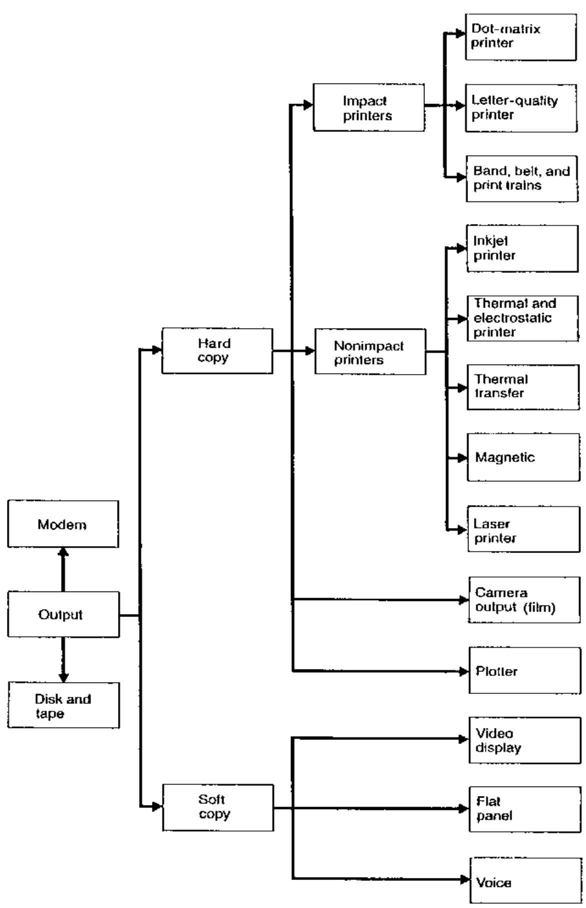
-***Plotter*** and ***ink-jet printers*** are used in reproducing graphics and can produce color output.

- ***Thermal*** printers are capable of producing color printouts but are prohibitively expensive.

The output display is created by a ***cathode ray tube (CRT).*** The CRT scans the output in the form of electronic dots and lines, then displays the results on the screen. Each dot is called a ***picture element*** or, in computer terminology, ***pixel***. CRTs come either in monochrome or color. The high resolution monitor (CRT with more pixels) is ideal for graphic output.

Liquid crystal display (LCD) is another kind of display monitor available on the market. The LCDs are ideal for portable computers because they have a flat-panel display device with very little power consumption. The flat-panel display technology is new and researchers are in the process of improving the quality of this kind of output device to the level of a CRT or better.

Output Devices



Primary Memory

The process of entering data into either primary or secondary memory is called ***writing***, and the process of retrieving data from the memory is called ***reading.*** Two types of memory identified in primary memory are the ***random access memory (RAM)*** and ***read only memory (ROM)***.

The central processing unit cannot store all the instructions and data while running a program; therefore, it needs a storage unit. Think of a primary memory unit as post office mail boxes with each box having a capacity of storing one character, a byte. Each byte consists of eight bits or 0's and 1's (0 represents the off position and 1 represents the on position). This type of computer memory is often referred to as ***random access memory (RAM)*** and its capacity is measured by the number of boxes available for storing bytes. Memory capacity is usually measured in thousands and it is shown as K, the Latin symbol for thousand. Actually, K stands for 2 to the power of ten, or 1024 bytes. A computer with 128K memory has 131,072 boxes for storing characters.

The RAM memory is, as discussed before, temporary and if the power were disturbed for any reason, the data would be erased from the memory or the boxes would be emptied. This kind of memory is called ***volatile*** because it loses its contents when its power source is shut off. Random access (reading data) refers to the concept that the access time for one cell is the same for any other cell because the memory cells are arranged in rows and columns. Access to a specific cell is possible by addressing the row and column containing the cell.

ROM is a part of the memory from which information can be read, but cannot be written to or altered. ROM contains instructions for the computer on what to do once it is turned on. This part of the memory is permanent and ***nonvolatile***. The instructions are usually set in the factory and cannot be changed. However, some types of ROM can be programmed according to the user's specifications. ***Programmable read only memory (PROM)*** allows the user to program it. In another type of PROM, programs can be erased. This is called ***erasable programmable read-only memory (EPROM)***.

Secondary Memory

Data stored in the primary memory, as mentioned earlier in this chapter, is volatile and temporary. When the computer's power is disconnected, the data is erased from the primary storage. To ensure that the data is nonvolatile and permanent, it must be stored on a medium, ***secondary storage*** or ***auxiliary memory***, which enables the user to retrieve the data at a later time. The most popular storage medium today is a ***magnetic*** medium. Floppy disks, hard disks, tapes, and cartridges are often used. Another kind of auxiliary memory is an ***optical*** medium, which has a tremendous amount of storage capacity. Figure 2 illustrates types of secondary memory devices.

Data is stored in the form of ***files***. A file is defined as an organized collection of data about specific topics or items. For example, a list of students in a class is a file. A file has a name which serves as the identifier of the file. To retrieve a file, the file name must be input into the computer. Two types of file access are common today, ***sequential*** and ***random***. A sequential method accesses files from beginning to end in straight order. If the user wants to access the last file, all of the previous files must be read first. Payroll files organized by employee numbers are a good example. Random access, on the other hand, can be obtained directly regardless of the location of the file in the storage medium. Student files made up of records using test scores are

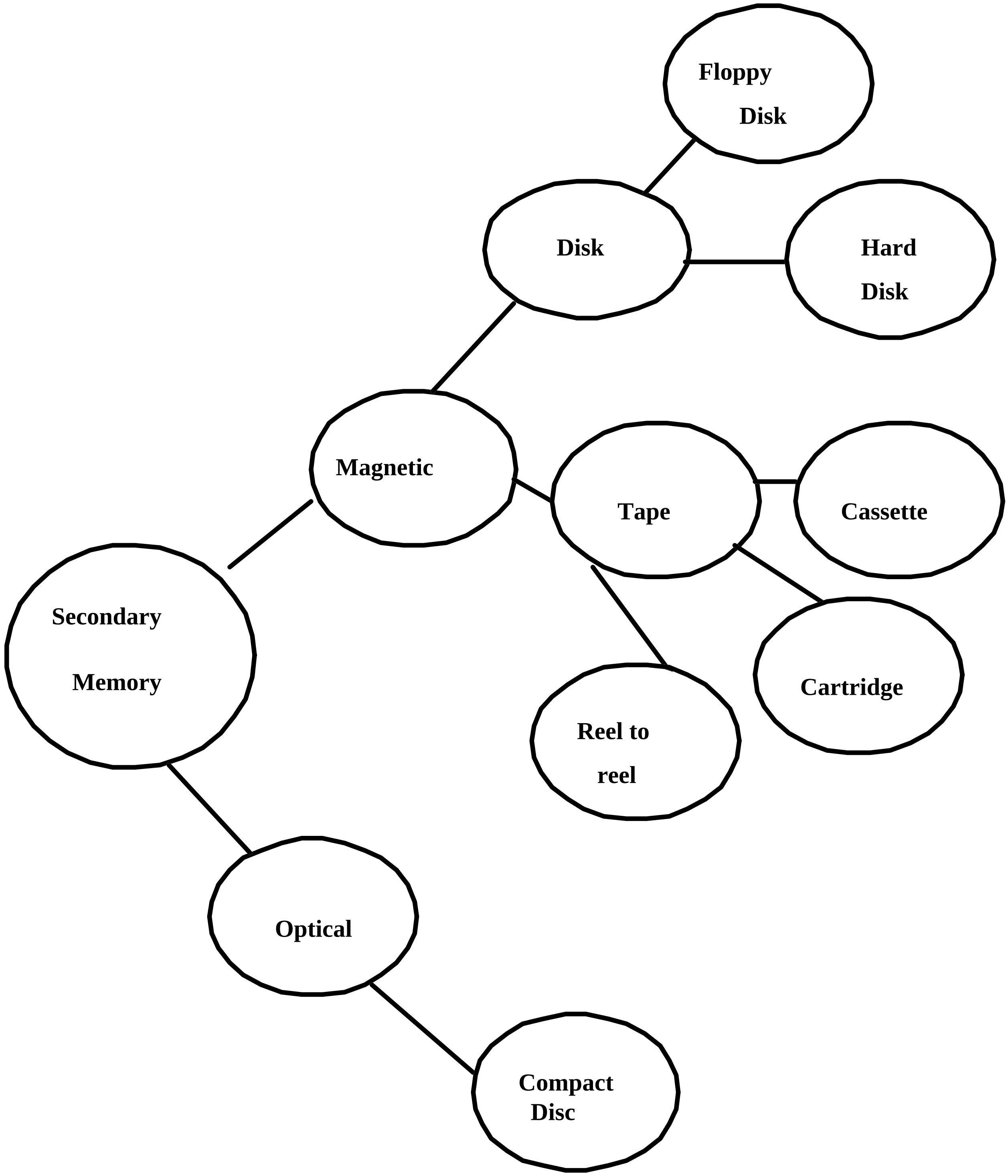


Figure 2. Types of secondary memory devices. Magnetic and optical memory devices are two major storage media.

an example of random access files. A disk can be used to store and retrieve files in sequential and random access, whereas tape can only be used to store or retrieve sequential files.

Magnetic medium storage devices are very common today. Magnetic tapes come in three formats: cassette, cartridge, and reel to reel. The tapes are coated with a thin film of an easily magnetized substance so data can be recorded on it magnetically. Tapes were the most widely used storage medium in early computing, but in 1972 IBM introduced flexible disk to the market. Optical discs were recently introduced into the market and possess the ability to store much more data through laser technology.

In the early 1950s, tapes were made of flexible metal and coated with a thin film of iron oxide. Plastic Mylar later replaced the iron oxide. Storing data on the tapes is possible by exposing the tape to a magnetic field and arranging the metal particles in two directions, south and north, in order to record either 0's or 1's. The magnetized fields are converted into electrical pulses by the tape drive and sent to the computer's processor. Tapes are a sequential access medium and are relatively slow. The other drawback to using tapes as a storage medium is that to change or update even a small section of a file, the entire record must be changed. Most of the early microcomputers used cassettes as an inexpensive storage medium. Today, however, large computers use tapes as a back up storage medium because of low price and great storage capacity.

Floppy disks are the most popular secondary storage medium and are used mostly for microcomputers (Figure 3). They come in three sizes: 3-1/2, 5-1/4 and 8 inches. The storage capacity of a disk is determined by the disk's density and whether it is single sided or double sided. Data is stored on the surface of the disk, which is divided into circles or ***tracks***. In order to use a floppy disk, it must first be ***formatted*** by dividing the recording surface, or tracks, into smaller addressable units called ***sectors***. Each floppy disk is divided into forty fixed tracks but the number of sectors is not standardized yet. If the factory formats the disk and it cannot be changed by the user, it is called a ***hard-sectored disk***. On the other hand, if the user formats a disk by the operating system, it is called a ***soft-sectored disk***.

Hard disks store data in the same fashion as floppy disks. They come in sizes of 14, 8, 5-1/4, and 3-1/2 inches. Data is stored on a rigid platter coated with iron oxide on both sides. Capacity varies from 10 MB (ten million bytes) to 1 GB (one gigabyte, being one billion bytes). The access time is much faster than with floppy disks.

The magnetic storage medium has capacity limitations. With our information-oriented society, the need for a greater and cheaper storage medium is increasing. One answer to this demand is ***compact disc (CD)*** technology. A twenty-volume encyclopedia can be stored on a less than five inch diameter CD with storage room to spare. The CD is an optical storage medium which has a light-sensitive layer, protected by a rigid surface. Data is recorded on the CD by a laser beam. CDs are capable of storing data, images, and sound together. Currently, there are three kinds of CDs on the market: read only optical disc, write-once-read-many (WORM) CDs, and erasable CDs. Most of today's CDs are not erasable.

Operating Systems

An operating system is a collection of programs, often supplied by the computer manufacturer, which coordinates computer system activities. The operating system coordinates and systematizes the flow of data and work through the microcomputer system.

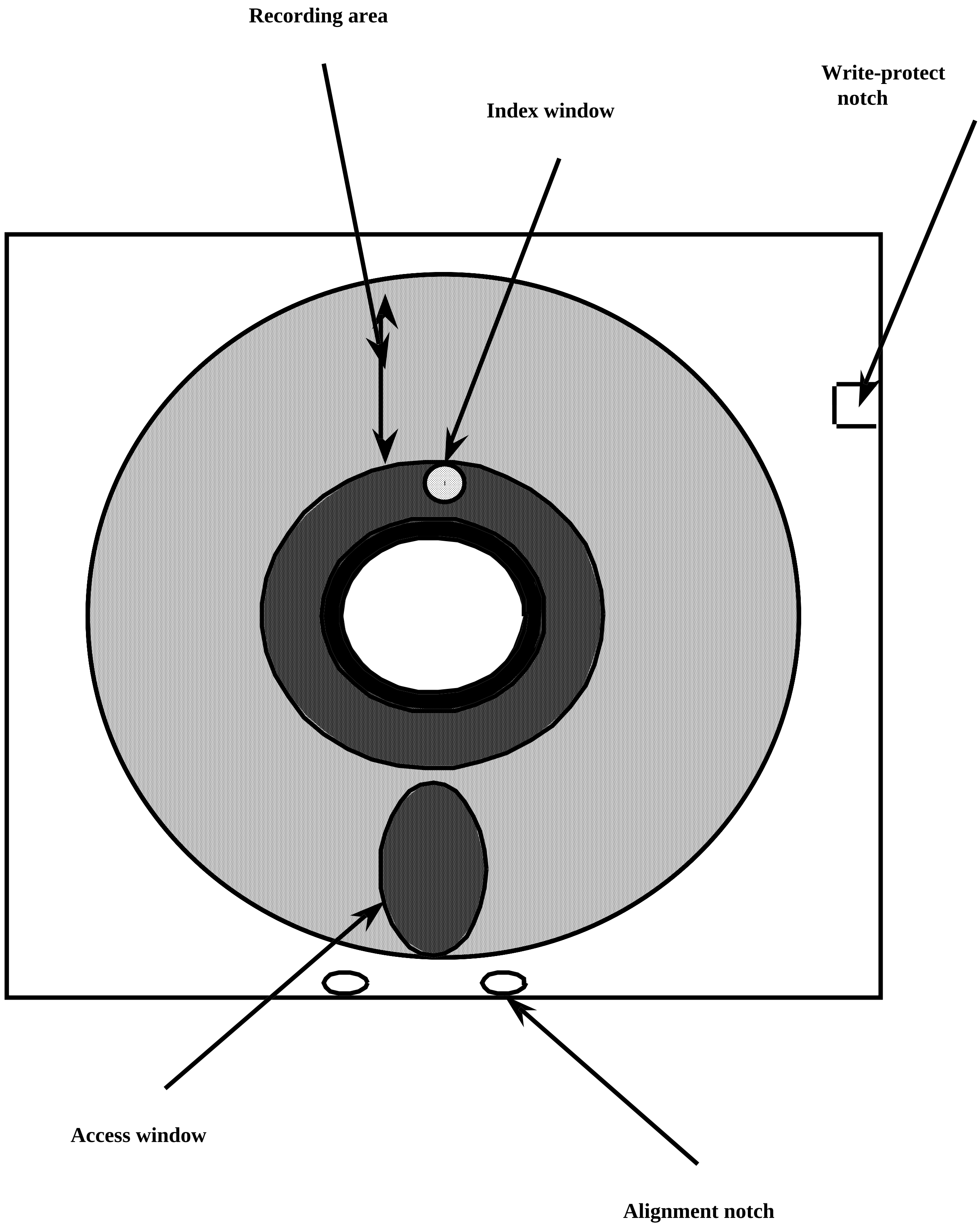


Figure 3. Floppy disk. Data is stored on the recording area in sectors and tracks.

An operating system stands between users on the one hand and hardware and software on the other. Operating systems manage hardware components, direct the flow of data through input/output devices, and facilitate communications between users and the CPU.

Disk Operating Systems (DOS)

A Disk Operating System (DOS) is a set of programs that helps you use the files on the disk. A ***file***, as was defined before, is a collection of related information, or a set of computer records that has been stored together on a disk for some common data processing purpose.

DOS is usually specified by the software developer. For example, PC DOS (Personal Computer Disk Operating System), developed by IBM, or MS DOS (Micro Soft Disk Operating System), developed by the Micro Soft Company. DOS performs the following tasks:

- Starts new programs.
- Provides disk status information.
- Opens and closes files.
- Copies files.
- Saves files.
- Deletes files.
- Formats disks.
- Identifies and catalogs disks.

Classes of Computers

Computers are classified according to their size, speed, memory capacity, options, cost, and so on. With the new technology and a "super computer on the desktop" concept, computers are becoming smaller and faster, with larger memory capacity and more options. Generally, computers are classified as follows: microcomputers, minicomputers, mainframes, and supercomputers.

Microcomputers

A microcomputer (micro) is the most popular type of computer on the market. Since the late 70s, when the microcomputer entered the market, sales have been increasing dramatically. Some believe that the spread of the micro was much faster than the spread of television. It is estimated that in 1990 about 60 million micros were in use in the US. Major reasons for the micro's success are its low cost, ease of use, and general usefulness. The size and price of micros are decreasing as the speed and memory are increasing. Micros started with a desktop concept. Then laptop, a portable computer that could be carried around, was developed. A hand-held, light, and powerful small computer with the features of a desktop computer is now becoming popular.

Micros, nicknamed ***personal computers (PC)***, are based on ***microprocessors*** . That is, the CPU (ALU, control unit, and primary storage unit) is often on a single chip. Microcomputers are usually identified by the type of microprocessor used. For example, Apple Macintosh uses

Motorola 68000 series chips, Apple IIe uses MOS Technology 6502, Apple IIGS uses 65C816, IBM PC XT uses Intel 8088, IBM PS/Model 80 uses Intel 80386, and Kaypro II uses Zilog Z-80A.

Minicomputers

Minicomputers are general purpose computers. They are very useful for scientists, engineers, smaller businesses, colleges, and universities. Minicomputers are faster than micros yet have a greater storage capacity. In the mid 1960s, Digital Equipment Corporation (DEC) introduced the first minicomputer to the market and it became successful. It was a scaled down version of a mainframe computer, cheaper and easier to operate.

A minicomputer is ideal for centralized data processing tasks and can be a multi-user system, supporting several hundred terminals at the same time. In addition, temperature and humidity control are not as restricted as in a mainframe environment. A variety of peripherals can be connected to the minicomputer. Due to a sophisticated operating system, minicomputers are powerful enough to be programmed in different programming languages.

Mainframe Computers

A mainframe computer is a large-scale computer which was first built on a main frame or chassis. It is capable of processing data at very high speeds. Its primary storage capacity is measured in millions of bytes. Its secondary storage is in billion bytes, and it has a potential for add-on peripherals. Government agencies, state and local agencies, banks, industries, manufacturers, and hospitals are the major mainframe computer users. Mainframe computers are very expensive and prices range from several hundred thousand dollars to several million dollars. It is extremely important to monitor the mainframe computer environment. Controlled air conditioning, humidity, and power supply are required. Most companies prefer to lease the computer rather than purchase it because of the high initial and maintenance cost. Lease options provide update privileges, too.

One of the greatest advantages of a mainframe computer is ***time sharing***. Time sharing is a process of accessing the same computer at the same time by many people. The computer processes the data individually but the processing speed is so great that users do not feel the time lapse. More than 1,000 terminals, including minicomputers, can be connected to a mainframe.

Supercomputers

The supercomputer is the fastest, most powerful, and expensive computer. It has a huge primary and secondary storage capacity. Supercomputers are the utmost in computing power available today, with the ability to process 64 to 128 bits at a time and the ability to process up to 1.2 billion instructions per second. Although more than 10,000 terminals can be connected to a supercomputer, a mainframe or minicomputer is needed to coordinate the input and output activities.

Supercomputers are used extensively in aerospace technology and have great use in scientific research such as geographical data, genetic engineering and weather forecasting.

The supercomputer must be kept in a controlled environment because it generates so much heat requiring a special cooling system. The CPU of Cray 2, one of the most widely known supercomputers, is called a “bubble” because it is immersed and cooled in a tank containing coolant liquid. The cost of a supercomputer starts at about 4 million dollars and can go up to close to 20 million dollars.

Programming Languages

A ***program*** is a set of sequential instructions that tells a computer to perform specific tasks. A program is a type of communication between the user and the computer. Often the word "program" is used interchangeably for software; however, software is a broader term. Like computer hardware, computer programming went through an evolution and became more user friendly and efficient. Different classes or generations of computer programming are recognized as follows:

- First generation or ***machine language.***

- Second generation or ***assembly language.***

- Third generation or ***high-level language***.

- Fourth generation or ***fourth-generation language (4GL)***.

- Fifth generation or ***natural language***.

Machine Language. Because computers are based on a binary number system (0, 1), the computer only understands 0's and 1's. This is called ***machine language.*** The computer programmer has to enter data in the form of 0's and 1's. This type of programming is also called ***low-level language***. It is a very time-consuming process and such programs are extremely difficult to correct or debug. For example, to write "HI THERE" in machine language, the following codes have to be entered; 1001000 (H) 1001001 (I) 1010100 (T) 1001000 (H) 1000101 (E) 1010010 (R) 1000101 (E). In addition, the programmer must have a detailed knowledge of how computers work. In spite of these drawbacks, machine language has a fast execution time and uses primary storage efficiently.

Assembly Language. Another type of low-level language programming is ***assembly language***, which uses alphabetical abbreviations to represent computing functions. For example, instead of using 0's and 1's to represent MULTIPLY, assembly language uses the code word MUL. The designer of an assembly language creates a program, called the ***assembler***, that will read a user's assembly language program and translate it into machine language.

Programming in assembly language is very tedious and requires a detailed knowledge of the computer's internal operation. Assembly languages are used mostly in developing operating system software, especially in the portions involving input, output, and other machine dependent resources. Assembly language is where speed and memory usage are very important.

High-Level Language. In the mid 1950s, the first higher-level languages were developed. The idea was simply to bring the computer's language level up to a human level. In this high level programming language, the designer concentrates on developing a language that is convenient for solving certain computing problems. In order for the computer to understand the instructions, the program must be interpreted into machine language. This is possible through a translator called a ***compiler.***

A variety of higher-level languages have become popular. The first of these was **FOR**mula **TRAN**slation (***FORTRAN***), which was developed to solve scientific problems where a large number of calculations are required. **CO**mmon **B**usiness **O**riented **L**anguage (***COBOL***) was designed to solve data processing problems in businesses. **B**eginners' **A**ll purpose **S**ymbolic **I**nstruction **C**ode (***BASIC***) was developed at Dartmouth College and was a simplified version of FORTRAN. Higher-level language is easier to learn, requires less time and effort, is easier to correct, and does not require the programmers to have detailed knowledge of the computer's internal operations.

Fourth-Generation Language (4GL). Programmers have always tried to develop a programming language which requires less effort to learn programming procedures. Fourth-generation language is more user-friendly and produces better and faster results. In addition, 4GL needs minimum maintenance by reducing errors and making programs that are easy to modify. Fourth-generation languages are getting closer to the programmer's dream, natural language. They are mostly used in conjunction with a database. Basic- ally, 4GLs are quite useful in handling any type of problem whose answer is likely to end up in a row-and-column format, or whose complex nature reflects logic and data manipulation. Fourth-generation languages are used in strategic planning, budgeting, modeling, simulations, and the like.

Natural Language Processing (NLP). The fifth generation of programming language is defined as the ability of a computer to understand instructions in natural languages like English. In NLP the user communicates with a computer as one would with a colleague. This increases the computer's flexibility. For example, a teacher may ask:

PLOT THE SCORES FOR ALL OF THE STUDENTS IN

SIXTH GRADE

TELL ME THE TOP THREE STUDENTS

TELL ME THE TOP SCORE IN MATH

NLP started as a project of the US Department of Defense to translate the Soviet Union's technical documents into English, but the ambiguity of the natural language, like idioms and expressions, remained unsolved. In order for the computer to understand a natural language, it should contain the following knowledge: rules needed to make judgments about language, the meanings of phrases or expressions, and the meaning of words in context.

NLP is considered a programming language for intelligent computers. Some progress has been made in making natural language programming a reality. For example, Toshiba's office automation project includes a voice-activated word processor and an optical character recognition system that reads handwritten manuscript.