What are Computers

For tracing the evolution of computers, we will have to go back to the age of discovery of numbers and counting systems. Counting with the aid of pebbles was perhaps the first calculating technique used by the human beings. However, the credit for being called as the first computer goes to 'Abacus' a counting machine used by the ancient Orientals. It is more than 5000 years old and is still the primary form of "number crunching" in many parts of the world. In its present form, it makes use of beads to represent decimal numbers as shown in Fig. 31.1.

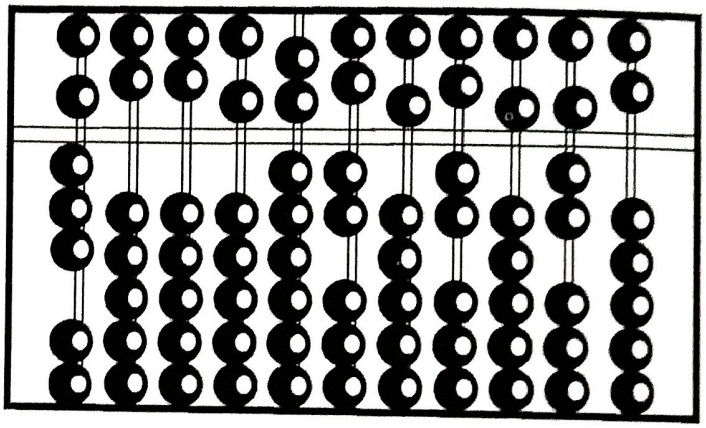


Figure 31.1 Abacus

The next attempt after the invention of the Abacus, for automatic computation, was made by a French scientist Blaise Pascal in 1642. He invented an arithmetic machine actually for the purpose of helping his father in his business of tax collection. This machine had eight wheels, each wheel having the numbers 0 to 9 painted on it. The wheels were attached to gears. The gears, in turn, were attached to each other in such a way that simple addition and subtraction could take place by dialing the amounts to be added or subtracted. Pascal's machine was, in fact, the first calculator and non-portable computer of the world. The computer world has acknowledged his contributions by naming a computer programming language as 'Pascal'.

In view of the above-mentioned historical evolution and also on its literal meaning, the term 'computer" stands for a device helpful in computing or calculating at a faster speed with greatest possible accuracy. However, as we know about the modern computers, their field is not limited to computation. They handle any type of information or data and work in almost all the fields of human endeavour. Therefore, to define them merely as a device helpful in computation is not justified. In search of some alternative definition, we can safely consider a computer as **a thinking machine of the human being that makes use of some well-framed meaningful programmes (software) for its operation and utilities.** Therefore, as a programmable machine, every computer is known to possess the following two characteristics:

1. Responding to a specific set of instructions, in a well defined way.
2. Executing a pre-recorded list of instructions (a programme) for performing various tasks.

In the language of technology, every computer is composed of two components (i) hardware (its machine like body), and (ii) software (the instructions followed for its operation and data which it processes for its utility).

Classification of Computers

Modern computers are electronic and digital. These digital computers are broadly classified into the following four categories depending upon their performance, size and cost:

1. Microcomputers (or micros)
2. Minicomputers (or minis)
3. Mainframes
4. Super computers

Microcomputers

These are low-cost small-size computers. These have been so named on account of their employing micro-processors. They represent a typically single-user systems, meaning that a microcomputer can be used by only one user at a time. The personal computers (PC) that you are using in your computer laboratory are microcomputers. These are named personal on account of being used by any person (without specialized training) for his personal use.

Minicomputers

These perform better, are larger in size, and cost more than microcomputers. They also possess larger storage capacities and are faster. Normally, they are designed to support more than one users at a time. That is why these may also be used as servers in local area network (LAN). Minicomputer, thus as a multi-user computer, can support ten to hundreds of users simultaneously.

Mainframes

These computers are more powerful and faster than minicomputers. They have a quite larger storage capacity and are able to support many hundreds of users simultaneously. Their real values lie in their processing power to handle large database systems, i.e. handling the records of thousands of employees working in an organization. On account of their large support base, they can be safely used as servers in WAN.

Super computers

Where microcomputers lie at the lowest end of the computer range, the super computers stand at the highest end (apex). They are the most powerful, fastest and expensive machine and thus, can be afforded only by rare organizations working on the national level. These computers have remarkable performance as billions of calculations may be performed by them in a second. Some of the areas in which these are in use are sophisticated scientific and biomedical

researchers, weather forecasting, designing of sophisticated machines and warfare equipment, etc.

General Structure and Working

The structure and working of a computer resembles the human brain. In general, a computer system consists of the subsystems, namely: (i) Input, (ii) Memory, (iii) Arithmetic and logic, (iv) Output, and (v) Control.

1. The **input** subsystem in the form of keyboard cassette recorder, etc. works for putting outside information in the machine just as our eyes, ears and other sense organs work for our brain to collect information from the environment.
2. The **memory** subsystem helps in storing information and data electronically which can be retained indefinitely and used when needed. However, this memory is erasable and hence the stored information can be replaced with new one within a few microseconds.
3. The **arithmetic and logic** subsystem is the arithmetic and logic mind of the computer. It is responsible for all types of data manipulation and computation work. This work is carried out with an unimaginable accuracy and extremely high speed.
4. The **output** subsystem resembles the output system of our brain to furnish the answered information. Whereas in our case it is done orally and by writing, in computers it is carried out through display (visualized) in the screen of the monitor, the printer (in the form of printed material) or the cassette recorder (voice).
5. The **control** subsystem, as the name suggests, controls the execution of the programme and coordinates all the activities of the computer. It functions in two phases in a cyclic manner: (i) the instruction phase, and (ii) the execution phase. In the former a command of the programme is brought to the control subsystem from the memory, and in the latter the command is executed.

The arithmetic and logic and the control subsystems together is called the central processing unit (CPU) or simply the **processor** signifying that what is to be processed in the machine is done through CPU (Fig. 31.2).

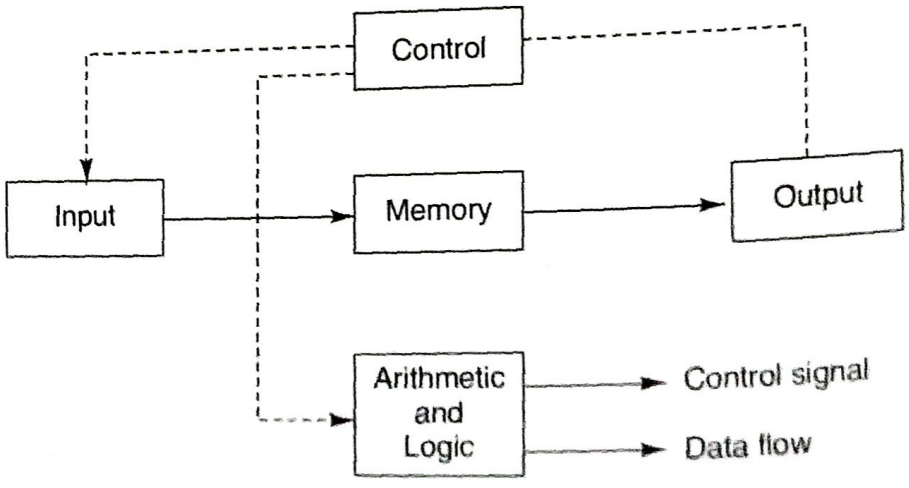


Figure 31.2 Working and organizational structure of the subsystems of a computer

The computers in all their sizes and applications are machine-like devices and, thus, belong to the family of hardware. They possess vast memory, unusual flexibility and unimaginable scope for computing and manipulating data in unlimited ways. For this purpose, like other hardware, computers make use of software. The software used in them is in the form of a written programme prepared by human being. A computer works in the manner what it gets in the form of programme. That is why, the computer in itself is not an independent thinking machine, but a machine of a thinking man, the programmer. The job of a computer programmer is quite technical which needs the knowledge of the language spoken by the computer and its coded specific instructions, besides the knowledge of the subject matter and instructional technology.

Language of a Computer

The computer language serve much the same purpose as a human language, i.e. communication. But they can't communicate in the languages of ours. They have their own languages such as BASIC, PILOT, LOGO, FORTRAN, COBOL, and JAVA, etc. If we wish to communicate with them, we have to know their languages. Each of these languages tries to adopt a particular type of number system—binary, hexadecimal or octal system, etc.,—in place of the usual decimal system adopted by the human beings for the general computation work. Most of the computers make use of the binary system with two-digit symbols, 0 and 1 (instead of ten digits, 0 and 1 to 9) for expressing any number as illustrated in Table 31.1.

TABLE 31.1

Number	*Expressed in Computer Language*
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000

For expressing in computer language, the alphabet, operations, etc. are first given specified code number as given in Table 31.2 and then transformed into computer's language.

TABLE 31.2

Instruction	*Operation Code No.*	*Expressed in Computer Language*
Add	1	0001
Subtract	2	0010
Multiply	3	0011
Divide	4	0100
Read a card	5	0101
Square	6	0110
Draw a line	7	0111
Transform	8	1000

Components of a Personal Computer (PC)

Your PC has a machine-like body and components (referred to as hardware) and a set of instructions (called programmes or software) for its operation and use. Let us first know the hardware components of a PC. As shown in Figs. 31.3 and 31.4, the hardware, i.e. the physical components of your PC, may be divided into three main units. These are now discussed in detail.

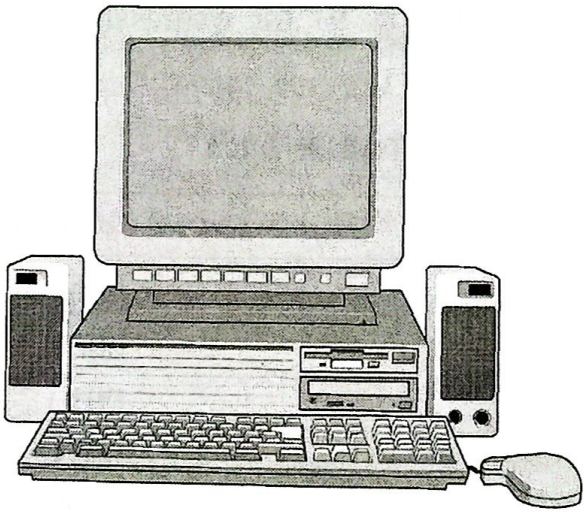


Figure 31.3 Personal computer (monitor is placed on CPU).

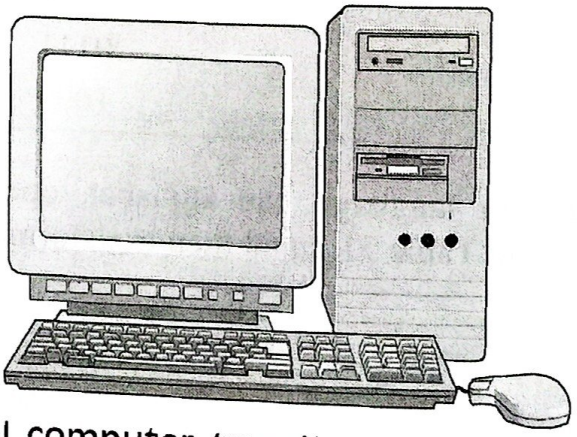


Figure 31.4 Personal computer (monitor and CPU are placed separately).

Input Devices Unit

The input devices are those devices or equipment meant for feeding data and instructions into the memory of the computer. For example, we may name keyboard, mouse, scanners, light pen, etc. Some of the most common input devices are given below:

Keyboard

It closely resembles a typewriter. It has a set of keys for enabling you to enter data into the computer. It has 101 keys containing letters, numbers and symbols, like an ordinary typewriter. Besides these, it contains a variety of other keys:

1. *Function keys:* These are 12 keys found on the top left-hand side of the keyboard and are named F_1, F_2, ..., F_{12}. They are used to perform special functions depending on the software used.
2. *Numeric keyboard:* It is located on the right-hand side of the keyboard. It looks and functions like a calculator.
3. *Special keys:* These are meant to perform special functions like controlling the movement of the cursor on the computer screen.

While working on your PC using a keyboard, you must have noticed a flashing point on the computer screen (monitor). It is the **cursor**. For the movement of the cursor, the keyboard has the following special keys:

- Four directional arrow keys for moving the cursor one space at a time either up, down, left or right direction.
- The keys such as Home, End, Page up, and Page down for moving the cursor quickly over longer distances. The page up and page down keys are in fact used to "Scroll up" and "Scroll down" the page length of the screen.

The other special keys (besides the cursor movement keys) on your keyboard are identified in Table 31.3.

TABLE 31.3 Special keys on the key board

Special keys	*Functions*
Del	Deletes characters
Ins	Inserts characters
Esc	Stand for ESCAPE, is used generally for cancelling a command.
Backspace	Erases the character to the left of the cursor.
Ctrl and Alt	Control key and alternate keys. They have no function alone. They are able to input special messages to the computer when passed with other keys.
Enter	Executes an instruction or data being keyed in through the keyboard.
Caps Lock	Used for keying in capitalized alphabets.
Shift	Behaves differently when the Caps Lock key is off or on.
Caps Lock off	If pressed simultaneously with a character key, it can input a capitalized alphabet.
Caps Lock on	It reverses the above effect.

Mouse

It is an alternative device to the keyboard for controlling the movement of the cursor or pointer on the computer screen. It looks somewhat like a mouse with a tail (in the form of its connecting wire) hence the name. The mouse may have one, two or three buttons (Fig. 31.5). The function of each button is determined by the programme that uses the mouse. Rolling or moving the mouse on a flat surface (usually a mouse pad) causes a corresponding cursor movement on the computer screen. Whenever you press one of the buttons it will either mark a place on the screen or make selection from data on the screen. This quality of marking makes the mouse useful for graphic programmes to draw pictures by using it like a pen, pencil or paint brush. Similarly, its selection characteristic makes it popular selecting any option by simply clicking the button. Hence, the operation of a computer is often nicknamed as a clicking of the mouse button in relation to the programmes available in the computers.

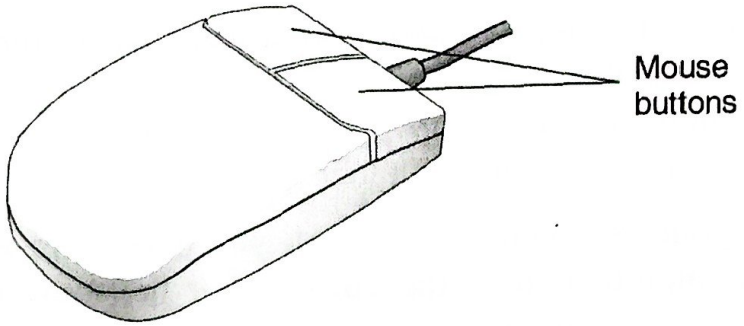


Figure 31.5 A two-button mechanical mouse.

The type of mouse you generally come across in your computer lab is a mechanical mouse. In a mechanical mouse, the ball that projects through the button surface rotates as the mouse is moved along a flat surface (the mouse pad). The direction of this rotation is detected and relayed to the computer by the switches inside the mouse. On the other hand, another variety of mouse named as optical mouse uses a light beam (laser) instead of the rotating ball to detect the movement. The optical mouse responds more quickly and precisely than the mechanical mouse, but on account of being more expensive, it is rarely used in the labs of the institutions.

Light pen

It is a pen-like pointing device used to select an option by simply pointing at it, or to draw figures and graphics directly on the computer screen. Now it has similar functions as that of

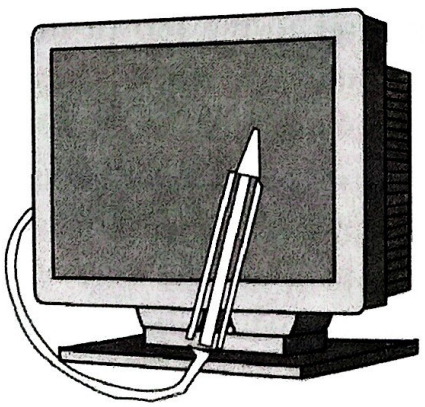


Figure 31.6 A light pen.

a mouse. In terms of technology, a light pen is found to utilize a light-sensitive detector for selecting the options or drawing the figures on the computer screen.

scanner

Many times you face the situation when some information (text or picture) is available on paper and you need it on computer disk for further editing or incorporating it in your prepared document. The solution may be taking a photograph of the image directly from the available source, getting it converted into a form for being saved on the disk and then finally having its print through the printer.

What you need as above can be safely and effectively done through a scanner. Scanner may be considered as an input device that can read text, picture or graphics printed on paper and translate the information/image into a form (code) capable of being processed by the computer. Scanners that you will mostly find in your computer labs are of two types: (i) the flat bed, and (ii) hand-held.

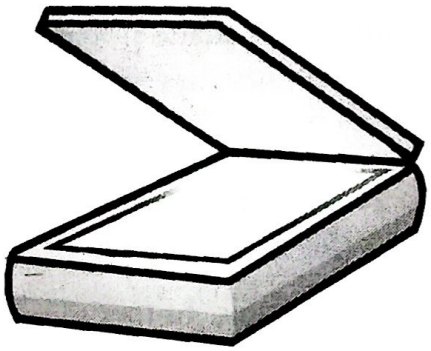


Figure 31.7 Flat-bed scanner.

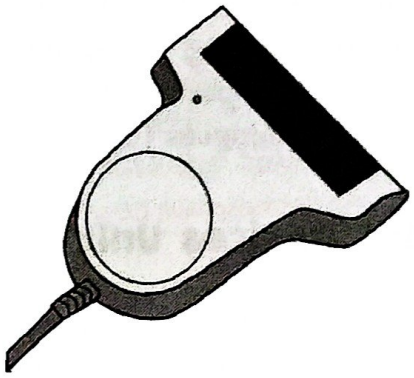


Figure 31.8 Hand-held scanner.

The hand-held scanners are appropriate for small graphics, photos and pictures but they do not suit the page-sized text or graphics. In the latter situation, the flat bed scanners are more suitable. They can scan and store images from books like a photocopier. Their operation also is quite easy. You are simply required to lay books, magazines, or the page of which you want to scan. Here even you don't need to remove the page from the original source.

The scanners as input devices are advantageous on many fronts. They may be used

1. to reproduce photographs on the computer screen.
2. as a photocopier for scanning text and graphics.
3. to integrate text and graphic files.
4. in so many educational, official and business purposes such as desktop publishing, storage of documents on the computer, demonstration and instructional aids in the classroom teaching, seminar and training programmes.

Digital camera

It is used as an input device for feeding images into a computer (Fig. 31.9). We can take still photographs with the help of it. Such photographs after being stored in the camera are sent as digital input into the computer. The computer is capable of storing them as digital files.

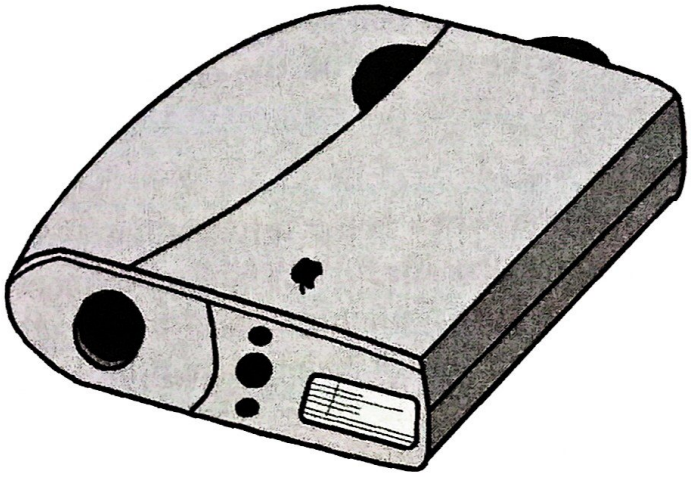


Figure 31.9 A digital camera.

We can then make the stored digital images (in the files) by manipulating them in many ways, with the help of tools available in the computer's software programmes. It is quite customary to transmit these images (photographs) for showing on the screen of the computers as a part of video conferencing or transmitting them through e-mail. It has made possible to view the scenes and photographs of distant relatives by utilizing the Internet services along with hearing their dialogues (by using a special hearing device).

Output Devices Unit

Output refers to any information or result coming out of a computer. In this sense, the output devices may be considered as those devices that help in providing information or results to the users by getting the same from the computer. Examples are monitor, printer, plotter, speakers, etc.

Let us know about some of these commonly used output devices.

Monitor

It is also known as visual display unit (VDU). The outcoming information or results (after being processed by the computer) are displayed in a visual form on the screen of the monitor. Since, here, the output from the computer is communicated to the user through the display

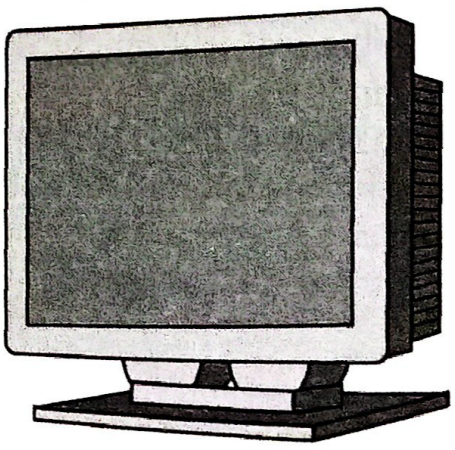


Figure 31.10 A monitor (visual display unit).

on the screen, the visual display unit, is also shortly named as display screen or screen. However, the term monitor, refers to the entire display unit, whereas the display screen may mean just the screen.

As a visual display device, the monitor allows viewers to have information about the results of processing unit of the computers. However, as it is attached with the keyboard, it can be used for viewing and checking the input provided to the computer through typing using the keyboard. It can display the outcoming data or information from the computers in the shape of both text and graphic images. This display can be either in black and white or in colour. Nowadays, we generally make use of colour monitors. There are many brands available in the market representing different styles, shapes and sizes, price range and quality. The typical size of the screen of most of the personal computers is 14 inches or 16 inches. However, besides the size of its screen and colour display, the quality of a monitor is more judged in terms of its resolution, i.e. a measure of number of pixel, the short form for the Picture Element. A pixel is a single point in a visual display. The greater the number of pixel, the sharper will be the image or visual display. Hence, for getting fine results, the monitors with a satisfactory level of resolution should always be preferred.

If you need permanent copy of the information you have entered into your computer on paper, you have to make use of a printer attached to your PC (see Fig. 31.11). In this way, the printer represents those output devices attached to the computer that help in getting the results of the computer's processing on paper and in many cases, on transparencies and other media in the shape of text or illustration.

The printers are available in a number of types, varieties and styles. The choices for using in your computer lab mostly depends on the speed or printing quality of their output, the present price range and economy in terms of their use, etc. However, nowadays three types of printers are most popular with the PCs. These are dot-matrix printers, ink-jet printers and laser printers.

Dot-matrix printers: It prints the individual character in the form of dots by striking pins against an ink ribbon. The number of pins in the print head may vary from 9 to 24. A printer having more pins in its print head is considered better as it helps in getting better printing. The dot-matrix printers are able to print both text and graphics in any language or form without additional hardware. We can also have coloured prints by changing ribbons. They are quite inexpensive. However, these printers are not much favoured in comparison to ink-jet and laser printers on account of the following reasons:

1. These make much noise.
2. Their speed of printing is quite low.
3. Their print quality is very inferior in comparison to other printers.

Ink-jet printers: These printers use jets of ink to print fully formed (not dots) characters on the paper. By jets of ink we here mean that the printers are capable of spraying ink from tiny nozzles through an electrical field for the printing of characters at a high speed, i.e., 250 characters per second. The sprayed ionized ink is absorbed and dries instantly on the

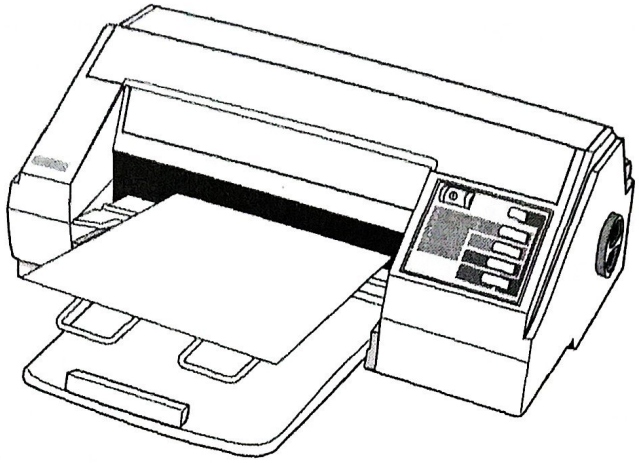


Figure 31.11 Ink-jet printer.

paper. These printers are more popular in comparison to dot-matrix and laser printers on account of the following reasons:

1. Do not have unpleasant noises like dot-matrix printers.
2. More reliable in terms of their functioning and output.
3. Capable of producing high quality printing.
4. Require smaller mechanical parts and thereby are portable.
5. Provide an inexpensive way to print fully coloured documents.
6. In terms of speed, quality of printing and economy, they fall midway between the dot-matrix and laser printers.

Laser printers: These use a combination of micro-electronic, laser-beam technology and photocopying technology. In their operation, thus, they utilize a light beam to form images on the paper using toner ink as the medium. The laser printers are very much ahead of the dot-matrix and ink-jet printers in terms of the speed and quality of printing. They are capable of printing up to 20 pages per minute, both text and graphics in any colour or black and white using an almost unlimited variety of fonts. On account of these qualities, these printers are most popular in the publication business of the texts and graphics. However, these are less commonly used in our computer labs and homes only on account of being quite expensive.

Plotters

These devices help in creating high quality graphics (like charts, graphs, tables, diagrams, pictures and other computer-aided designs) on paper in multiple colours. They are used when the printers fail to serve the required purposes.

In composition, the plotters differ from printers in that they draw lines using pens attached to moveable arms. As a result, they are able to produce continuous lines in contrast to the printers that can only simulate lines by printing a closely spaced series of dots. Like printers they can be available in two different shapes and styles, as flat-bed plotter and drum plotter. In a flat-bed plotter, the paper is held stationary while the arm and the pens move over it. In the drum plotter, the paper is wrapped around a drum and anchored at both ends. The drum rotates while the pen moves laterally along a fixed rail.

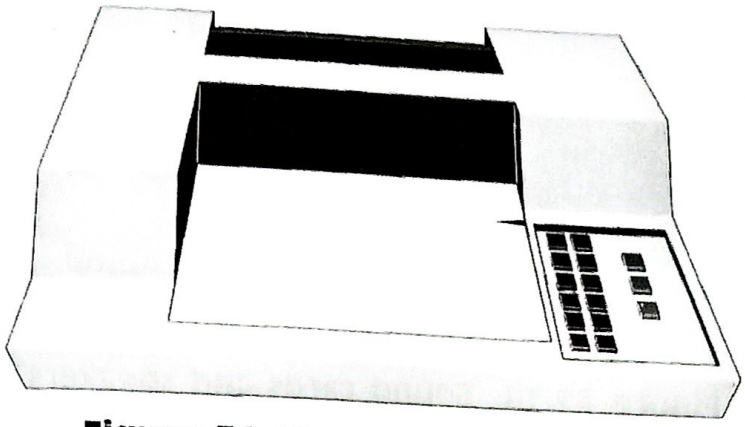


Figure 31.12 A flat bed plotter.

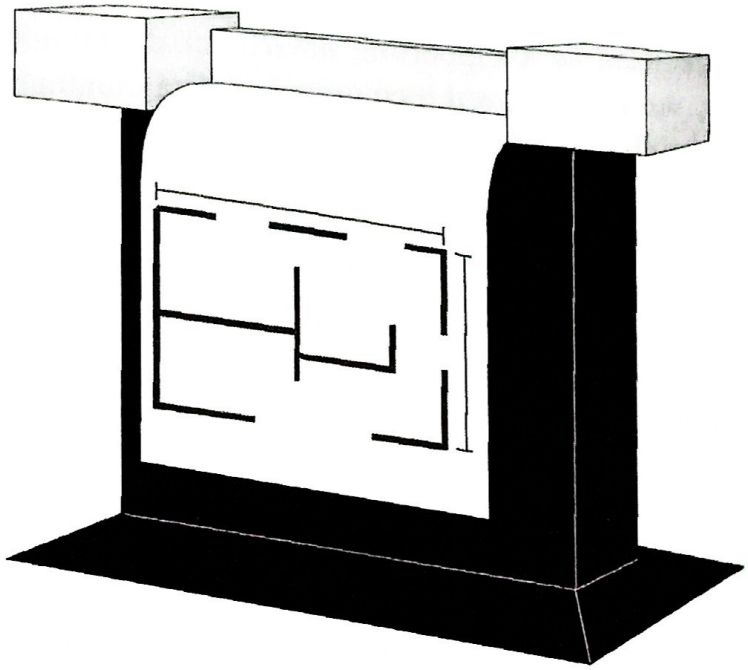


Figure 31.13 A drum plotter.

The quality of production from plotters depends on the quality of the pens, inks and the papers used for printing. Like printers, a plotter may be connected to your PC through the parallel port and can print as and when ordered by the computer.

In general, however, the plotters are not available for printing in the computer labs of the institutions as these are quite expensive devices in comparison to the printers.

Sound cards and speakers

These devices help the user to get output from the computers in the shape of sounds (information and results through hearing). These devices are quite common to the PCs nowadays. The sound cards usually help:

1. In the output of sound through speakers connected to the motherboard of the computer whenever instructed by software programmes.
2. In manipulating sound stored on a disk.

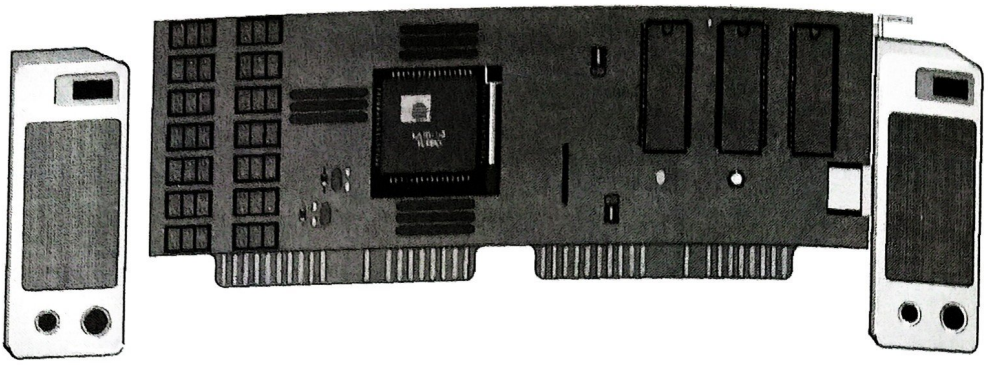


Figure 31.14 Sound cards and speakers.

With their utmost utility, sound cards have become a prime necessity for nearly all CD-ROMs. The music and entertainment programmes of all sorts also are run with their help. In modern times, they are used as a supporting device for communicating worldwide. For communication purposes, we usually need a computer, a data communication package and a modem. The sound cards and speakers with a little more additional device of a hearing and speaking aid may help us speak and hear the voices of the person sitting at a distance through the telephone lines and digital signals of the satellite communication systems. It has made possible the task of on-line conferencing for deriving personal, educational and professional benefits.

Central Processing Unit

The central processing unit or CPU of the computer falls midway between the input and output devices. Whenever any data is fed into the computer through the input devices, it is processed and the resultant output is provided through the output devices. The unit of the computer where this processing is carried out is CPU. Its main component responsible for the actual processing is the **microprocessor**. The other important component of this unit is the **memory** consisting of data storage and retrieval devices. Let us know something about these components.

Microprocessor

This is the main driving engine of the computer. There are various types of microprocessors (made out of chips) available. At present, the **Pentium** is the most powerful microprocessor manufactured by Intel. The capacity of a microprocessor is measured in terms of the number of bits it can send or receive and process internally. Let us understand the meaning of the term 'bit'. As we know, the binary system (consisting of two digits—1 for on and 0 for off) is used in the computers. Each of these binary digits is called a **bit** and the collection of 8 bits representing a character of storage is called a **byte**. A modern microprocessor (32-bit processor) has a 32-bit data path meaning thereby that it is capable of sending, receiving and processing 32 bits of data at a time. This 32-bit processor will certainly have double speed in comparison to an old 16-bit processor.

In its composition the microprocessor consists of the Arithmetic logic section (for executing arithmetic and logic instructions) the Control section exercising control over the data worked

upon by Arithmetic logic section, and the Registers (for the presence of local memory needed by Arithmetic logic section). In functioning, all these sections work in union for providing required output to the users with the help of various output devices.

Memory (storage and retrieval devices)

It is that component of the computer system which works for the storage and retrieval of data and instructions. The computer has two types of memory, (i) internal memory, and (ii) external memory.

Internal memory: It is present on the motherboard of the computer in the form of chips. It is also referred to as internal storage, primary storage or main memory. The following two types of internal memory are used by PC:

1. Random Access Memory (RAM)
2. Read Only Memory (ROM)

RAM is the memory that the computers use for storing the programmes and their data while working on them. It is called Random Access Memory as it is possible to use any location in the memory at random to store data and instructions temporarily. You can retrieve data from these locations after their being stored on the hard disk and continue working on the document. It is also called read/write memory as data within it can be read and modified (written). When the computer is switched off, the data stored is lost if not saved properly in a location.

The other type of internal memory found on the motherboard is called ROM. While manufacturing the ROM chip, the desired instructions are permanently stored on it. The information on such a chip can only be read. Nothing fresh can be written on it. In this way, ROM can be said to contain permanently recorded instructions that are quite essential for operating the computer. Unlike RAM, the data stored on a ROM is not lost when the power goes off.

External memory (secondary storage devices): Your PC has a limited internal storage capacity. It places restriction on the amount of data processed. Hence, you need some extra means for the storage of more data. You have also noticed that in case of a power failure or switching off the PC by you, all the data stored in the internal storage is lost. It is a serious limitation. Here certainly you need some means for the permanent storage of data. Both these purposes, permanent storage of data and the increase in the capacity of storing data, can be very well served through the external memory sources produced by external storages devices, also known as secondary storage devices. The common examples are floppy disks, hard disks, CD ROMs, magneto optical (MO) disks, etc. Let us know something about these secondary storage devices.

Floppy disks: Often called floppies these are small, flexible and soft magnetic disks. These are removable as well as portable. You can insert or remove them from a disk drive of your computer at your will. As a result, these can be very well employed for moving data from one computer to another and for backup (keeping copies of your files and data).

The floppy disks are in two sizes. 5½ inch floppies are now not much in use. Thus, you will be mostly using 3½ inch floppies (Fig. 31.15). Such floppies are made up of flexible plastic coated with magnetic oxide. These are circular in shape with a hole in the centre. These are placed in a square size plastic jacket or cover for protection purposes. The jacket has head slot (read/write opening) for the exposure of a portion of the floppy surface. The head of the floppy drive (a device used for retrieving and recording data) makes contact with the exposed surface of the disk while reading or writing information.

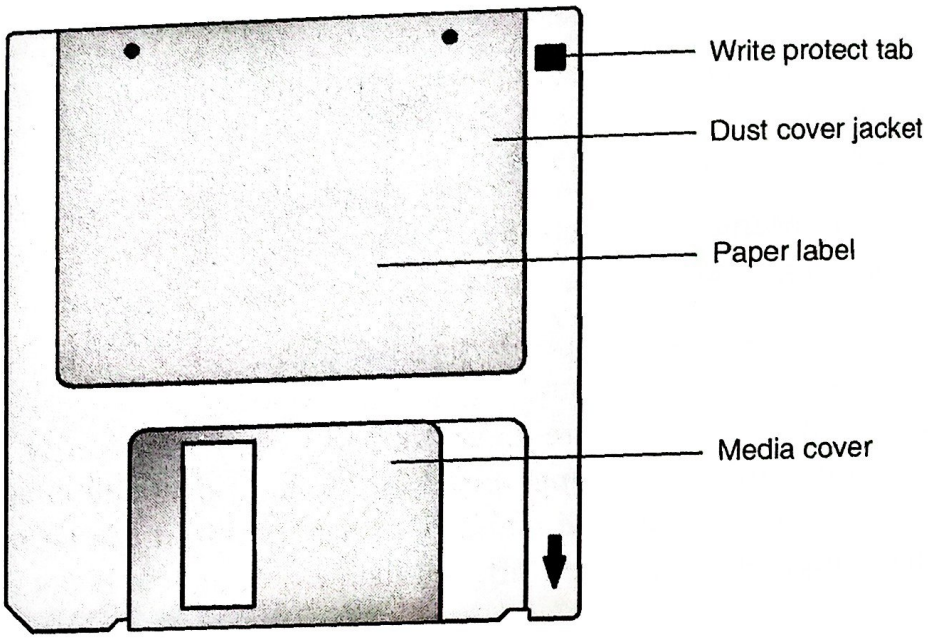


Figure 31.15 A 3½ inch floppy disk.

The floppy drive is used for the task of reading or writing data on the floppy. In the case of hard disk, a hard disk drive performs the same function. Therefore, it should be made clear that the microprocessor does not perform the task of writing or reading from the floppy or hard disk. However, these disk drives are contained within CPU.

The data can be stored on one or both sides of a floppy disk. Most of the PCs now use double-sided disks. A double-sided high density floppy of 3½ inch size can store 720 KB or 1.44 MB data.

In computer language, the storage capacity of a PC is measured in terms of bytes. It is the small basic unit like gram utilized for measuring weight. One byte can store one character, i.e. any number, alphabet or other symbol. In this sense, to store the word 'EDUCATION', 9 bytes will be needed. For higher measurements, we have kilobyte (KB), megabyte (MB), gigabyte (GB), terabyte (TB), etc. The conversion formula is given below:

1 KB = 1024 bytes or characters
1 MB = 1024 KB
1 GB = 1024 MB
1 TB = 1024 GB.

Hard disk: As the name suggests, it is a hard and inflexible magnetic disk. It is made from aluminum and other metals. It is permanently housed in a sealed and contamination-free

container and is located inside CPU of the computer. Hard disks are faster than floppy disks and can also hold more data (as high as 500 MB on a disk of 3½ inch diameter). In addition, a hard disk is very reliable safe storage device in comparison to floppies. There is no danger of its getting contaminated or damaged by heat, moisture and dirt like floppies.

Optical disks: In these disks, the data is read and written by using a laser beam (Fig. 31.16). The storage capacity of these disks is much more than the magnetized disks (as far as up to 6 GB, i.e. six billion bytes).

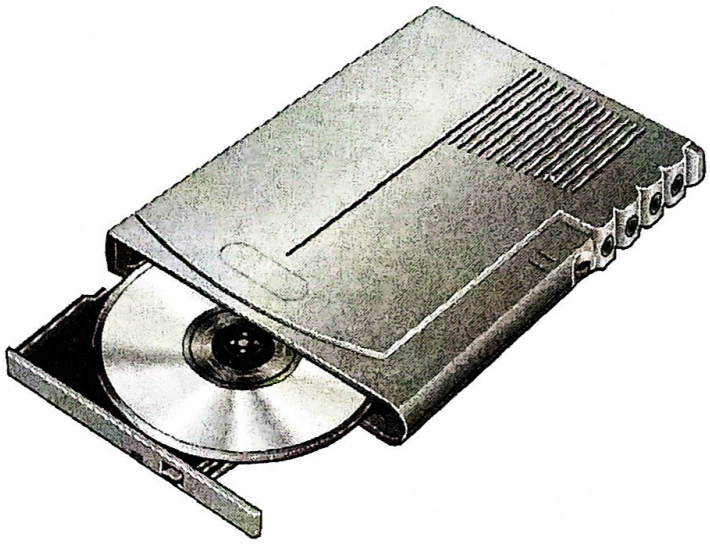


Figure 31.16 An optical disk.

CD-ROM: It is a short name used for the Compact Disk Read-only Memory. This optical disk is capable of storing large amount of data (up to 1 GB) just equal to the storage capacity of 700 floppy disks. However, the data stored in it can only be read. The manufacturer of the CD-ROM writes or records data on CD-ROMs by using a high intensity laser beam. Once recorded, they cannot be modified, erased and filled with new data. You can only read the

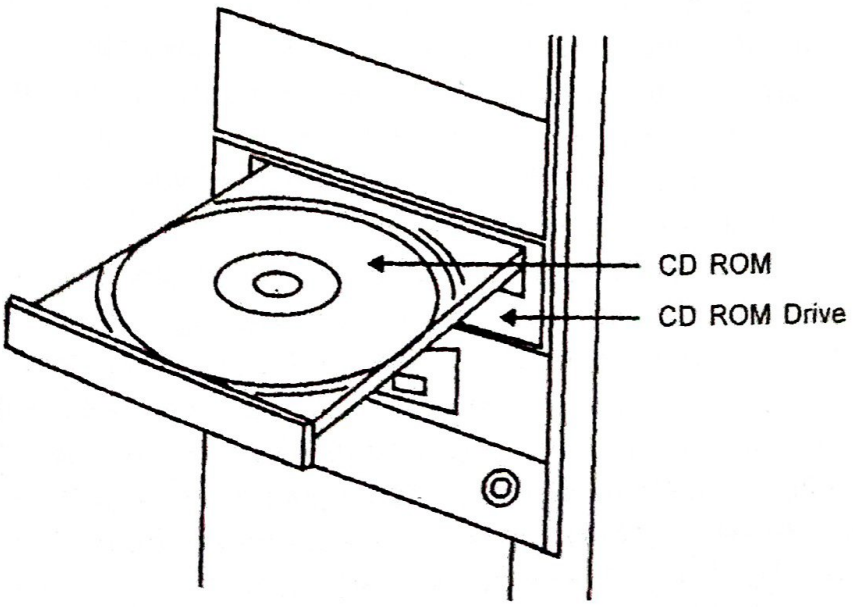


Figure 31.17 An Internal CD-ROM Drive with a CD-ROM Disk.

recorded data by using in input device called the CD-ROM drive that employs a low intensity laser beam. CD-ROM players or drives may be internal or external. In the case of internal, a CD-ROM drive is provided in the CPU itself. CD-ROMs as useful storage devices can safely be employed for listening, viewing and making use of any information recorded on it. Now it is possible to modify or write information on a CD-ROM disk with the help of a special device, called CD-Recorder.

CD-RW: It is a short name for Compact Disk Re-Writable. It differs from CD-ROM in the sense that here you can write and read data in the way you do with a floppy or hard disk. However, for doing this you need a special drive known as CD-RW drive (Fig. 31.18)

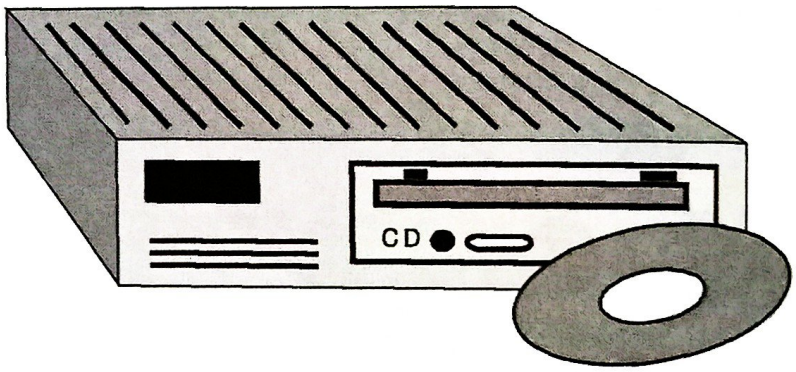
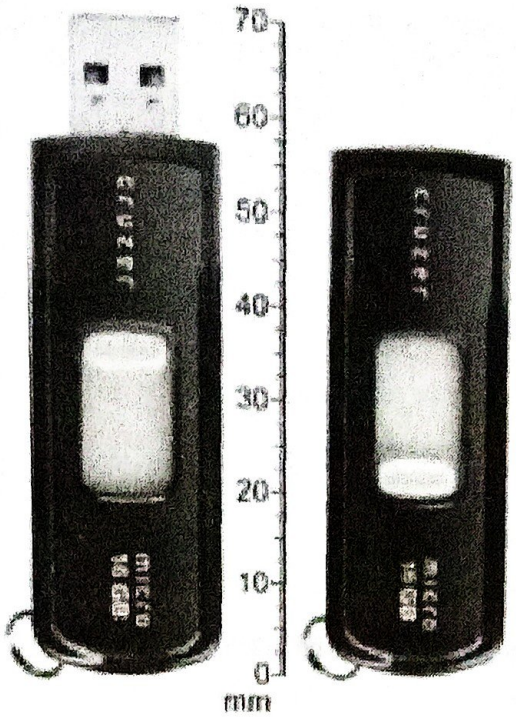


Figure 31.18 CD-RW Drive.

Magneto-optical disks (MO disks): These advanced types of disks make use of the magnetic as well as optical disk technologies thus getting the facilities of both magnetic and optical disks. As a result, (i) they prove quite safe from heat, dirt or moisture, (ii) the data can be read and written, (iii) these are portable like floppies, (iv) their storage capacity matches with optical disks as they can store data with capacities of even 2 GB (4 GB in case of double-sided), and (v) data can be directly overwritten on existing data during an overwriting operation (disks are rewritable over 1 million times).

Pen drives: In the sequence of modern computer memory (storage and retrieval) devices, pen drives represent a portable USB (universal serial bus) flash memory devices that can be used for storage of audio, video and data files with the additional facility of quickly transfer these files from the hard drive of one computer to another. With a construction that is small enough to fit into a pocket, the pen drive drives its name from the fact that many of these USB devices resemble a small pen or pencil in size and shape.

In its structure a pen drive consists of a small printed circuit board protected inside a plastic, metal or rubberised case, robust enough for carrying with no additional protection-in a pocket or in a key chain, for example. The USB connection is protected by a removal cap or by retracting into the body of the drive, although it is not liable to be damaged if exposed. Pen drives, thus represent the typically shock proof, dust proof, removable and re-writable devices that are much smaller than a floppy disk (1 to 4 inches or 2.5 to 10 cm) and weigh merely 20 grams or so. These need no batteries, have no moving parts and are available in the range of storage capacity from 32 MB to 64 GB.



(a) Ready to use (b) Closed after use

Figure 31.19 A 16 GB USB pen drive.

Pen drives offer unique advantages over portable memory storage devices particularly the floppy discs. They have a more compact shape, operate faster, hold much more data, have a more suitable design and operate more reliably due to lack of their moving parts. Moreover, these are more suitable to the demands of the modern PCs and laptops equipped with USB ports instead of the floppy disc drives. They are capable of beating optical disc drives in this regard, as a pen drive with USB-2.0 support can operate faster than an optical disc drive, while storing a large amount of data in a much smaller space.

Utilisation of the pen drives is also a quite simple task. You have to insert your pen drive into a USB port of your PC or laptop like putting a blank CD. One end of the pen drive is equipped with a USB connector at one end. The connector is inserted into the USB port on a PC or laptop and activated. With its insertion, a pen drive is automatically activated. You can copy the data stored in it in your computer files or send the data stored in a computer files for the storage in the pen drive in no time with great ease and convenience.

Introduction

Computer is the finest and most important gift of science and technology to the mankind. It has done miracles in almost all walks of life. Today, there is no aspects of our life that remain untouched by the use and application of computers. In the field of education too, these are being used for managing its affairs including the actual teaching. With the introduction of New Education Policy in 1986, our country also have taken initiative for making their use in the teaching-learning activities. The instructional work so carried out with the help of computers is generally known as Computer-assisted Instruction (CAI). In this chapter, we will know something about such type of instructions.

Computer-assisted Instruction

Meaning and Definition

Computer-assisted instruction (CAI), as the name suggests, stands for the type of instruction aided or carried out with the help of a computer as a machine. It is just one step ahead of the use of teaching machine and, probably, two of the use of programmed textbook in making the instructional process as self-directed and individualised as possible.

The computer is said to be ahead of the teaching machine on account of its capacity of doing more work and multiple types of works at the same time for an unlimited number of individual learners than the teaching machine. CAI instruction, for this reason, is relatively a new and developed concept than the teaching machine and programmed learning-oriented instructional technology. As observed by Hilgard and Bower (1977), "*Computer-assisted instruction has now taken as so many dimensions that it can no longer be considered as a simple derivative of the teaching machine or the kind of programmed learning that Skinner introduced*".

In this way, the fact stands quite clear before us. The use of computer has now almost revolutionized the field of instruction in all its dimensions. It can't be defined now as a teaching device for presenting programmed instructional material and, consequently, it will not be proper to define CAI as the type of instruction which makes use of computers.

Let us examine one more definition of CAI by Bhatt and Sharma (1992). They state that "*CAI is an interaction between a student, a computer controlled display and a response entry device for the purpose of achieving educational outcomes.*" This definition brings into limelight the following things:

- In CAI there is an interaction between an individual student and the computer just as happens in the tutorial system between the teacher and an individual student.
- The computer is able to display the instructional material to the individual student.
- The individual student takes benefit of the displayed material and responds to it. These responses are attended by the computer for deciding the future course of instruction displayed to the learner.
- The interaction between the individual learner and the computer device helps in the realisation of the set instruction objectives.

However, the above definition is somehow lacking in respect of giving the basic essentials about the nature and characteristics of the instruction provided by CAI. For doing away with such weakness, it can be modified in the following way: **Computer-assisted instruction is a method of instruction in which there is a purposeful interaction between a learner and the computer device (having useful instructional material as software) for helping the individual learner achieve the desired instructional objectives with his own pace and abilities at his command.**

Basic Assumptions

The computer-assisted instruction, meant for auto-individualized instructions, rests on the following basic assumptions:

1. Instruction for a number of learners at a time

CAI can serve at a time thousands of learners in an individualized way. What an individual needs according to his ability and interest in a particular subject or topic, and accordingly he can get the instructional material and help from the computer. Moreover, it is the best programmed instruction available to him in such a nice individualized way. Hence, the first assumption of CAI lies in its capacity of providing quality and quantity auto-instruction to a sufficiently larger number of the individual learners at a time.

2. Automatic recording of the learners' performance

How does an individual learner react to the presented instructional material? What are his quarries and difficulties? What is his performance in terms of learning outcomes? All such things can be successfully and accurately recorded by the computer device. It helps much in further planning the needed instruction to the individual learner for this proper advancement. This timely and proper auto-recording is the second assumption underlying CAI.

3. Variety in the use of methods and techniques

CAI assumes that every learner cannot be benefited through a single method and all the subjects or topics in a subject cannot be handled through a common method or strategies. It believes that there should be a wide variety of methods and approaches for imparting instruction in a particular subject or topic so that all the individual learners may be able to choose a particular method or approach according to their own interest, ability and nature of the instructional material.

Technologies of CAI

Computer assisted instruction requires a joint effort of various persons in the matter of wise handling of men and material resources. Generally, it involves three types of technologies, namely hardware, software and courseware.

1. Hardware

The computer as a machine represents the hardware. In CAI, we certainly need an appropriate computer to suit our teaching-learning situation. It will require the services of an expert or technician for its maintenance and an operator (a teacher, a student or assistant may do the job with some training). The teacher himself must have a workable knowledge of the construction and working of a simple computer.

2. Software

The computer cannot do anything for imparting instruction to the learners if it is not fed with the software. The programmes-containing instructions to the computer in a language that it can understand are called software. These programmes are developed by the experts called programmers. The software used in CAI is of two kinds: (i) application software, and (ii) system software. The application software includes instructions to the computer for carrying

out a total function required by the user. The user's concern is with this software. However, the system software is needed for organizing the resources of the computer to carry out the application tasks mentioned in the application programme. Its activities are: (i) to interpret the application programme in the code of the computer machine, (ii) to handle the input and output devices, and (iii) to schedule the work within the computer machine. Therefore, in a way, this software helps in the working of the computer or enabling it to do what is needed by the user in terms of its application.

3. Courseware

The courseware technology is the base of the instruction that is imparted to the learner by CAI. For example, a student of IX class wishes to learn about the topic "Elements, Compounds and Mixtures" in Chemistry. For this purpose, the computer machine as a hardware will need the services of software—the application and system programmes for its operation. These programmes will be prepared by the software programmer, an expert in the software technology. But for its preparation, he will certainly require the services of those who are experts in courseware technology who include: (i) experts in the subject, (ii) in the methodology and strategies of teaching the subject, (iii) in instructional psychology, and (iv) in audio-visual aid preparation and use. What the courseware technology will prepare in terms of the instructional material and method of instruction, etc. will be translated by the software technologists into software programmes for being used in the computer machine.

In this way, these three technologies and the persons operating them are jointly responsible for the preparation of the instructional activities conducted in CAI.

Types or Modes

Computer assisted instruction can take a variety of forms as detailed below for providing self-individualized instruction to a learner depending on the computer services availed.

1. Informational instruction

It helps the learner get the desired information he needs. Here the computer can serve the role of an enquiry officer, to respond to the student's enquiry with answers it has stored. It provides minimal interaction between the student and the computer programme. The sole purpose of this type of CAI is to provide essential information for the acquirement of concepts and skills. However, the individual learner can learn a lot by adopting an enquiry or discovery approach towards self-learning through such instruction.

2. Drill and practice programmes

CAI provides the learner with different types of drill and practice programmes covering specific topics related to a particular subject. Through these, the services of computers can be properly availed for providing practice in something already learned in some other way. It helps in the development of a variety of skills. For example, for providing practices in multiplication skill, the computer may display on the screen a simple problem like $7 \times 8 =$ .....

The child is required to respond to typing the numeric keys of the keyboard. If the answer is wrong, the computer immediately displays WRONG and if the answer is correct, another problem for carrying out the practice is presented. These responses come within a fraction of a second, therefore, the child has not to wait for the answer for feedback. On the other hand, the computer has the required patience to wait and allow the child to go ahead with his own speed and intention of responding and move forward. The advanced programmes on drill and practice select the problems of varying difficulty levels on the basis of the student's performance during the earlier sessions. The computer is known to have a good memory for the errors of the learners and, therefore, proves a very effective teacher in providing the students proper material for their drill and practice.

3. Tutorial type computer-assisted instruction

In this type of CAI, the computers are engaged in actual teaching. Here they can play effectively the role of a tutor by maintaining a perfect interaction and dialogue with the individual students. The tutorial programmes are prepared not only to have instruction in topics such as Newton's laws of motion, sets and their operations, solar and lunar eclipses but also to provide sufficient practice, having proper track of the student's difficulties and performance and move the students on the path of progress according to their own pace, abilities and requirements. If the student has been able to master a concept, the CAI programme provides the next step of instruction, but if he is not able to achieve mastery, the programme provides remedial instruction.

4. Educational games type

In it, the learners are provided with a variety of well-designed computer games. These games should not be confused with academic type games. Their purpose is only to provide intellectual challenge, stimulation of curiosity and serve as a source of motivation to the individual learner. In a course of learning, these games can be used as a source of review or as a reward for some accomplishment for the learner.

5. Simulation type of instruction

Simulation is used as a technique for providing training to the students. Such type of instructional activities provide powerful learning tools to them. With the carefully prepared programmes, the students are made to face real or idealized situations. They have to play an active role and are required to take decisions that have consequences. For example, a simulation computer programme may put the participants in the shooting range of the enemies in the battlefront or in the role of a hunter in a jungle full of horror or beasts or in the role of an explorer who is looking for a buried treasure. The stimulation in all these proves much less expensive and dangerous to have a trainee blow up something on the screen than to face a real danger to make a real mistake while trained in real situations.

6. Problems-solving type

This type of computer-assisted instruction focuses on the process of finding an answer to a problem rather than the answer itself. Here, the students are provided with programmes that

can make them think about the ways and means of solving the problem systematically. With the concrete ways suggested in the programmes, the students can divide or analyse the problem into its small constituents and are able to devise systematic procedure for its solution. One of the best known problem solving instructional material packages is Logo, a procedure-oriented language based on the learning theories of Jean Piaget. Besides, there are other programmes available for different types of students for increasing the sophistication of their thought process helping them learn good thinking strategies and problem solving abilities.

7. Practical work-oriented instruction

CAI programmes can provide valuable help in supplementing laboratory and other practical work. A student can learn so many things about the science experiments before actually performing them in his practical class by watching and following a computer programme made for this purpose. Similarly, he can avail the necessary skills and experiences about practical tasks in other fields before actually engaging in such practical activities. Thus, the children will have a necessary preparation and background from computers for their better performances at the school hours.

8. Learning affairs-managing type

In this type of instructional activities, the computer-assisted programmes provide valuable help in managing and supervising the learning affairs of the students. They can have a proper check over the learning activities of individual students by identifying their academic weaknesses through extensive diagnostic testing and to prescribe educational programmes to meet their individual needs. They can give assignments, help in self-study, library reading, group work, take a test over assignment, keep progress chart and guide the teacher as well as parents to plan their children's education. In the subjects and areas needing extensive computation and manipulation of data, such as mathematics, engineering, statistics and advanced researches, the computers can do wonders. A mini computer can do and replace the work of a giant calculating machine. In the education of the handicapped children, e.g. deaf and dumb, the computers can provide the needed learning experiences with quite negligible efforts to the children. In this way, the computers can play a leading role not only in managing the affairs of the teaching-learning process but also in the whole range and areas connected with the world of education.

Limitations and Difficulties

The computer assisted instruction as we have seen is available in its various types for helping the students in their auto-instructional activities. Though perhaps, this is the most workable instructional device run by the individual learner with little or no teacher assistance. Yet, when coming to the practical use, it is found to suffer from a number of limitations and drawbacks:

1. The instruction of CAI in classrooms proves quite expensive and uneconomical in terms of educational returns.

2. Computer, as an electronic device, may invite significant hazards to children. There is a potential danger for the children either to damage the machine or be damaged by it.
3. Much of the difficulty is felt on account of the unavailability or usability of the educational software. Either we don't get any programme for a particular type of instruction and teaching of a topic or we are cheated by the computer firms by selling us the software found virtually useless and unusable.
4. Serving of the hardware (computer machine) also poses a serious problem. If for one or the other reason the machine is failed, the expertise to operate it again or do repair work is not easily available. Consequently, the regular instructional work on self-study of the students may receive a major setback.
5. The auto-instruction or self-study carried out in the form of CAI is basically a learners-controlled instruction. Here, the learner is the master of the whole instructional process and thus, there is little scope for keeping restraint and checks on the learner. It may lead to indiscipline, truancy, carelessness and unnecessary wasting of time on the part of the students.
6. The learners are supposed to type from the keyboard or use light pens against the screen for putting up their responses. During long study hours, this exercise may prove quite boring, mechanical and tiresome. However, they have to live up with it as a way to interact with the computer on account of the fact that there is no computer till now that can communicate and respond to the speech and writing of the students like their teachers.
7. CAI, how good and effective it may prove as an instructional device, cannot be accommodated properly in the set-up of our schools or colleges comprising set time-table schedules, uniform curricula and groups-oriented instruction, and examination system. Neither we can replace or build up altogether a new structure nor can we dare to invite chaos by introducing CAI.
8. The other major limitations of the CAI lie in the fact that computers are machines and no machine can ever match the human beings for effective interaction with the human beings. The emotional touch, warmth and sympathy as well as the heart link established in teacher-pupil interaction are not possible in CAI.

These limitations and drawbacks, however, do not undermine the importance of computers as an aid to instruction. They are not to replace the teacher or the traditional teaching-learning system, but to render a valuable help to the teacher as well as learners in their pursuit of excellence with regard to their responsibilities towards teaching and learning. Moreover, it is useless to say that the use of computers in classroom at once needs some advanced technical skills on the part of the teachers. In all practical sense, the computers may be handled like other hardware: T.V., video sets, camera and projectors. Even if one does not want to learn anything beyond how to load a programme (software) in the machine and run it, it is at his choice. Surely, it will not come in the way of a teacher to use computer as an instructional tool. He does not need to prepare the software (computer programme) as these programmes may be procured from the market or borrowed from some concerned educational agency. Therefore, there is a great need of making suitable environment by removing all type of

hesitation and fear in the minds of the teachers for the adoption of CAI as a method or mode of instruction.

Computer-managed Instruction

Meaning and Definition

The term computer managed instruction (CMI) simply stands for the instruction managed with the help of computer technology. It directly calls for the services and applications of computers in the field of instruction. However, in the language of computer technology, computer managed instructions may be defined *as a category of computer programme that may be used by educators and instructors to organize and manage data related to instruction for attaining the stipulated institutional objectives in a most effective way.*

How are Instructions Managed by the Computers?

As said in the above definition, computers are able to perform the task of managing instructions with the help of a category of suitable software programme specifically designed for this purpose. Some of the functions performed with the help of such developed softwares related to the organization and management of instructions are described now:

1. Diagnosis of entry behaviour of the learners

Computer programmes help in the early diagnosis of the strengths and weaknesses of the learners in terms of their previous knowledge and experiences related to a particular knowledge and skill area, their interests, attitudes and aptitudes, the needs and motives as well as other personality traits for determining their potentiality for going ahead in the learning of a particular instructional course or achieving a set of instructional objectives.

2. Setting of instructional objectives

Computer softwares are available that can help in analyzing test data (results of the diagnostic testing) and the other database (pooled) information about the characteristics of the learners in relation to the needs and purposes served by a particular type of instruction at one or the other stages of school, college or public education. It will help in formulating the goals and objectives (educational as well as institutional) for a particular course or piece of instruction.

3. Generating individualized instructional plans

Depending upon the need, characteristics, nature and individuality of the learners, computer softwares are able to generate and organize individualized instructional plans for countless learners at one or the other times—average, gifted, slow or disabled.

4. Generating instructional materials and learning experiences

Suiting to the individualized instructional plans and strategies computer softwares can generate appropriate instructional material and opportunities of interactive learning experiences to the learners of varying needs, interests and abilities. A huge data bank of all types of information and instructional material is easily available through well prepared software packages, websites, online conferencing, networking, etc.

The material generated and developed for instructional purposes may be used on a computer based system or in other forms of instruction, for example, programmed instruction, multimedia self-instruction, or group instruction including slides or tape presentations. Most of the so developed instructional materials have been programmed in tutorial, drill and practice as well as stimulation and gaming modes and thus occupy significant advantages over the traditional instructional material available.

5. Availability of instructional material into curriculum units

For the proper organization and management of the instructions, an inventory of the instructional resources available to the learners may be stored in the computer's data bank. The total resources may be divided into properly required units having clearly specified set of objectives. There shall be clear directions available for telling the learners what to do for achieving the stipulated objectives. It may ask them to read a book, work off self-administered paper and pencil exercises, conduct experiment with a science kit, attend group instruction or see a film, and so on. It may also suggest the learners to take in the end a unit test after completing instructions or work prescribed for that unit. The computer after proper processing and satisfied with the progress of the learners, then may suggest him to proceed on to the next unit of the instruction.

6. Monitoring of progress

The computer managed instructions prove very effective in monitoring the progress of each and every individual learners in a quite satisfactory way. What one has done, is doing or will be doing in future can be properly monitored with the help of the great capacity of computers in keeping track of the countless learners in the progress of their instructional outputs. They are able to register the low achievement of the learners, detect the deficiencies in learning along with the possible causes and provide suggestions for overcoming the learning difficulties.

7. Providing remedial instructions

Computer software can very well manage any progress related to remedial instructions to the needy learners. On the basis of the learning difficulties diagnosed and the probable causes detected, these softwares now can suggest all the possible remedies helpful in the planning and organization of instructions. For example, if the student is feeling difficulty in the work related to a prescribed unit he may be helped in learning the necessary prerequisites for that unit so that he may no longer feel difficulty in learning that. However, if it is a motivational problem, a suggestion may be forwarded to him to review the goals or help him see the relationship between the present unit and the achievement of those goals.

8. Management of information and record keeping

Computer software may help in a big way for the collection, storage, classification and dissemination of information through a well-organized system of record keeping and its maintenance. Storage of information and record keeping are very much essential for the proper organization and management of instructions. The teachers and the learners may get a big help for their teaching and learning from the storehouses of such information data related to their respective field of teaching-learning. All types of information and data related to the interests, abilities, educational and environmental backgrounds of the learners belonging to their past and present can be very well available for the students in their instructional outputs and overall welfare. Their educational progress can be very well monitored and maintained through the help of a well maintained data record of all the individual learners which may prove quite helpful in maintaining an essential link between the classroom instructions and its administrative management.

9. Organization of testing and evaluation programmes

Computer software may provide valuable services in the task of managing and organizing testing and evaluation programmes related to classroom instructions and educational progress of the students in a variety of ways. They are helpful in assessing the study behaviour of the students for getting them admitted to a course of academic or professional study. Later on, day-to-day, periodic or end evaluation are all possible through the well-framed unit or course tests and other evaluation techniques available with the suitable software. Computer managed testing can set unitwise questions distributed over a category of objectives belonging to different domains of learners' behaviour from its pooled question bank by carefully selecting test items according to the difficulty level, discriminating index, the content covered, the objectives tested, etc. There is no problem of question leakage on the part of such testing. Moreover, a number of identical sets of question papers may be available for the proper administration and checking of malpractices during examination. The chances of grammatical mistakes, language and printing errors also are minimized with these testing programmes. Scoring and interpretation also are quite objective and mechanical leaving almost no chance of traditional human errors.

10. Generating all types of reports

Computer software help the processes and outputs of the instructional programmes by generating all progress and information reports related to the tasks of instruction. If you need the report related to the entry behaviour of the students, it is available on the computer's hard disk or files maintained for the purpose. You may have a printed copy of the same for planning the individualized instructions for your students. The data regarding the available instructional resources, aids and equipments, unitwise organization of the curriculum and the progress regarding the attainment of instructional objects are readily available to the learners and the teachers. The testing, evaluation and progress reports of the individual students and the group as a whole, generated through computers, can be sent to the parents for acquainting them with the progress of their children and seeking their help for their welfare. Such reports can also

be used for the removal of their learning difficulties or deficiencies and for nurturing their talents and creativity.

In this way, computer softwares and their applications may be utilized for arranging and managing all the essential affairs related to the processes and products of classroom instructions. However, the field of CMI cannot be limited to the boundary walls of the usual classroom and school students. It encircles all types of self-learning and distance education modes and reaches all types of learners and their instructions such as adult learning, mass education programmes, special educations, provisions to the exceptional, disabled and disadvantageous groups and children of the society. Thus, CMI may be credited nowadays to have the capability of managing the entire spectrum of the teaching-learning or instructional process covering all the fields and areas of our education system.