Chapter 1:
INTRODUCTION TO COMPUTER BASICS

INTRODUCTION

Computers! Amazing machines! We are living in the computer age today. Most of our day-to-day activities cannot be accomplished without using computers. Sometimes knowingly and sometimes unknowingly we use computers. Whether we have to withdraw money from an ATM (Automated Teller Machine retranslated as Any Time Money), publish a newsletter, drive a motorbike, design a building or even a new dress, go to a grocery shop and buy anything, from cookies to tyres for our car—all involve computer in one way or the other.

We are breathing in the computer age and the computer has gradually become such a dire necessity of life that it is difficult to imagine life without it. Computers are affecting every sphere of our life—be it government, business, education, legal practice, entertainment, defense or home—computers have become an indispensable and multipurpose tool.

Whereas supercomputers can forecast weather, embedded computers make smart devices like washing machines that beep when washing is complete or automobiles that give you warning before breaking down.

In this chapter we will see how computers affect our daily lives, its positive and negative effects, characteristics, history, the various types of computers and the tasks associated with them.

NEED FOR COMPUTER LITERACY

Computers have shaken up the world. They have made us dependent upon them. We expect them to be present at every place: be it the ticket reservation counter, the microwave or the car. Now that computers have moved into our society so rapidly, one needs at least a basic knowledge of computer skills to pursue one’s career goals and to function effectively and efficiently. We can say that computer literacy is the need of today and the voice of tomorrow to survive in the fast changing world of computers.

For most people computer literacy is restricted to using the keyboard for typing a document or making use of it for calculations. But this is not enough. One must know fundamental concepts such as what computers are constituted of and how they work. For example, you drive a motorbike and you take it for servicing. One way is to tell the service boy to service the motorbike and that you will collect it in the evening. Another way could be to tell him that, apart from servicing, please change the engine oil and clean the carburetor too. This way the service man would be more careful while working on your motorbike and you would be able to solve some of the small problems with your bike when the mechanic is not available. Lack of knowledge can sometimes be a cause of great trouble. Lack of knowledge can cause mistakes while using the computer. Lack of knowledge is also a cause of fear in some people. This fear is termed as CYBERPHOBIA. This is not a technical term. It is just used for people who are scared of using computers.

COMPUTER: THE DEFINITION

For most people, the computer is a machine used for calculations or computation, but actually it is much more than that. Precisely, "The computer is an electronic device for performing arithmetic and logical operations", or "The computer is a device or flexible machine to process data and convert it into information".

Now, in the two definitions given above, there are three tricky words that need some explanation. Let us start with logical operations – these are the type of operations in which decision(s) is/are involved. Data is simply raw facts or figures collected whereas information is what one gets after processing the data. Information is always useful and meaningful for the user. Let us consider an example in which the marks of various subjects are collected for a particular group of students. Now, these marks independently (data) are of no use as such for the class teacher, but once she adds the marks of all the students and calculates their respective percentages, this becomes information and it serves her in finding out the answer for the queries like – 'Who has stood first in the class?' or, 'how many people have got distinctions in the class?' or, 'what is the overall performance of the class?'

Computers are not only used for the purpose of calculations. An accountant or a grocery shop owner or a bank or an ATM uses it like a computational device, an author uses it as a writing tool, a musician as a device for controlling music, kids as a machine for playing games and so on.

Now, you must be wondering, what is so special about this machine that people from diversified fields can use it so flexibly for entirely different functions. The answer is that the computer is programmable, meaning that it all depends upon what program it is using for performing a particular function.

Now, the next question that comes to mind is, what is a program? In very simple language, we can say that a Program is a set of instructions that tells the computer what to do.

The computer hardware (actual machine) is designed in such a way that it does whatever the software (computer programs) tells it to do. We will be discussing the hardware and software of a computer in detail later in this chapter.

There are four basic operations which a computer performs, irrespective of the program which is running on it. They are classified as:

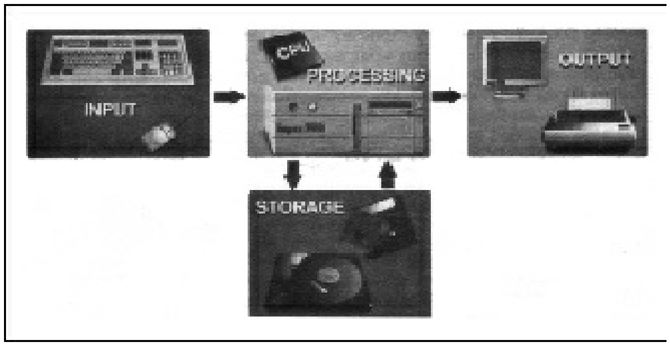


Figure 1.1

1. Input: This involves inserting or feeding data into the computer by means of an input device, like a keyboard.
2. Processing: Some kind of processing is done in the computer to take out or transform data in some way.
3. Output: The computer produces an output on a device, such as a printer or a monitor, that shows the result of the processing operations.
4. Storage: The computer stores the result of processing operations for future use in some storage device, such as a hard disk or a floppy disk.

These operations are often referred to as the IPOS cycle. The four steps of the IPOS cycle — input, processing, output and storage — may not necessarily appear in the same sequence as they are defined.

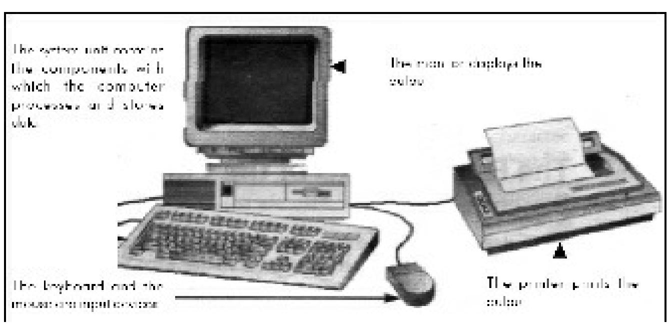


Figure 1.2

HISTORY OF COMPUTERS

Electronic data processing doesn’t go back more than just half a century. It has been in existence barely since early there 1940’s. The very first modern electronic computer became operational only in early the 1940’s. In fact, it's only a little more than five decades ago since the first modern electronic computer was brought into existence for the purpose of business data processing. Computers before that were used only in scientific and technological fields.

Although the present modern electronic computers are very recent, the idea was conceived far back. A brief outline of human history shows some interesting facts. In the early days when our ancestors used to live in caves, counting was a problem. They could, of course, count on their fingers, but gradually it started becoming difficult. As the belongings and possessions increased, the need for more counting tools grew. It was not possible to have more than 20 fingers (ten on hands and ten on feet). The record keeping system switched over to counting on a number of stones and scribbling on the walls of their caves. The inconvenience of being restricted to stones and walls forced them to look out for some other counting devices. In the mid-seventh century, adding tools and devices started being developed across the world. Thus we can say that the idea of computing is as old as civilization itself. It is very important to learn how people attempted to create early computers as they played a very important role in reaching this stage.

When people started using stones to count their animals or their possessions, they never knew that this would lead to the computer of today. People started following a set of procedures to perform calculations with these stones, which later led to the creation of a digital counting device, which could be thought of as the predecessor of a computer.

1450 B.C. Abacus (China)

The abacus is the first known calculating device. It was invented by the Chinese and is still widely used in the Far East for commercial calculations. In its primitive form, it consists of a wooden frame with a number of wires with beads strung through them. The beads are used for counting and calculations. To show a number, beads are pulled down so that each rod represents a digit.

1600 Napier "Bones"

This is another counting device invented by John Napier, a Scottish mathematician. The "bones" were strips of ivory with numbers written on them. When the bones were arranged properly, the user could read the numbers in adjacent columns to get the answer of a multiplication operation.

Between the 16th and 19th centuries, Europeans contributed their bit by inventing several machines that used existing technologies like clockwise gears and levers.

1642 A.D. Adding Machines (Blaise Pascal)

The well known French scientist and mathematician, Blaise Pascal invented the first machine, which could add and carry digits automatically. He was only nineteen years old at that time. His machine was so revolutionary that the principle behind it is still used in most of the mechanical counters being used today. He became a great philosopher and mathematician in Europe. His father was a tax commissioner and he used to accompany his father to his office. There he felt the need for an automatic calculating device, which could save people like his father from that boring and tedious job of doing sums over and again. He came out with a machine “Pascaline” that worked with clockwise gears and levers. The machine was basically developed to perform addition and subtraction operations only. The machine rotated wheels to register values and the lever was used to perform the carrying operations from one wheel to another. Although the machine was not accepted by business, it, however, initiated a series of inventions. To give honor to Pascal, a computer programming language was named after him. This language, Pascal, is generally used to teach programming to budding programmers.

1692 A.D. Multiplying Machine (Gottfried Leibnitz)

Gottfried Leibnitz improved upon Pascal’s machine and introduced a mechanism to carry out automatic multiplication of numbers. Leibnitz is best known for his work with Sir Isaac Newton in developing a branch of mathematics known as calculus. The calculator invented by him could add, subtract, multiply and divide accurately. It could even perform the square root function, although not always accurately.

1804 A.D. Jacquard Loom (Joseph Marie Jacquard)

In the early nineteenth century, a French weaver, Joseph Marie Jacquard developed a programmable loom, which used large cards and holes punched in them to control the pattern automatically. The output was a thick rich cloth with repetitive floral or geometric patterns.

Jacquard patterns are still produced to this day. Others adapted the punched cards and used them as the primary form of input. They were used till about 20-25 years ago.

1822 A.D. Difference Engine (Charles Babbage)

Since the early 19^{th} Century, Charles Babbage, an Englishman, had been working on the development of a machine, which could perform complex calculations. In 1822 A.D., he invented the 'Difference Engine', which could perform complex calculations and print them out as well. This machine was a steam–powered machine. While Babbage was working on his doctorate, he had to solve many complex formulae and he found it difficult to cope up with them in the given time period. This led him to the invention.

1862 "Arithrometer" (Charles Xavier Thomas)

This was the first calculator with commercial prospects. Frenchman Charles Xavier Thomas (a.k.a. Charles of Colmar) developed it. He won a gold medal at the International Exhibition in London. The machine performed addition, subtraction, multiplication, division and square root functions accurately.

1863 A.D. Analytic Engine (Charles Babbage)

Babbage had been working on a very elaborate machine all this time. By 1863 he had all the plans ready for the machine, which he named the Analytic Engine. He had conceived of a mechanism, which could carry out long sequence of complex calculations under automatic control. It would have the ability to store 1000, 50-digit numbers in one second and multiply 20-digit numbers in three minutes.

Babbage used a form of the punched card for inputting the data. That would have been a complete modern computer. However, technology at that time was not advanced enough to provide him with the hardware he required. He was thinking too far ahead of his time and his ideas could not be implemented. However, he was the first person to conceive the "Stored Program" concept.

Babbage worked on his plans for years. He was accompanied by Augusta Ada Byron (daughter of the famous poet Lord Byron) herself a brilliant mathematician, whose contribution to Babbage's work is tremendous. She is regarded as the first female computer scientist and programmer. A computer programming language, Ada has been named in her honor.

Charles Babbage is recognized as "The Father of Computers". Although his plans could not be materialized and his analytical engine could not be completed in his life span a working analytical engine was finally developed from his plans in the year 1991, and is on display at the Charles Babbage Institute at Minnesota.

1896 A.D. Punch Card Machine (Dr Hermann Hollerith)

Dr Hollerith is also a great figure in the history of computers. Dr Hollerith used the idea of employing punched cards in speeding up the collation job of the American Census of 1880 (The US Constitution calls for a census of the population after every ten years so as to determine the representation in the US House of representatives). He devised a card in which holes would be punched to indicate the presence of a particular criterion in a respondent. Using wire brushes in his machine the hole punched earlier in the card, enabled a wire to touch a metal plate, which carried an electric charge. The charge was transmitted to respective electric counters which automatically incremented the numbers. After the census was completed, Hollerith perfected his punched card equipment and marketed it. He founded the Tabulating Machine Company in 1896 to continue his work. Although the machines were in great demand Hollerith was not happy as he could not pursue his research work. In 1911 the Tabulating Machine Company merged with other two companies to form the Computing Tabulating Recording Company. Then Hollerith again started concentrating on inventing better equipment.

One of the partners, the marketing expert named Thomas Watson Sr., led the new company. Under his guidance, the company wrote great success stories. Finally in 1924, the management decided on a new name for the company and the Computing Tabulating Recording Company got converted into the International Business Machines Corporation (IBM).

His idea has been refined and improved further. Punched cards are still used for recording data items to be input to computers. During the Second World War, an acute need for fast calculating machines was felt to carry out complex defense calculations. The British and the American Governments sponsored a number of projects in major Universities for the development of fast and accurate calculators and computers. This proved to be a boon for the industry which has never looked back since then.

EARLY ELECTRONIC COMPUTERS

1930 Turing Machine

Alan Turing, an English mathematician, wrote a paper describing the capabilities and limitations of a hypothetical general - purpose computing machine called the “Turing Machine” in the late 1930's. Turing also helped in constructing Robinson (the British Computer used during the World War II) to decode German messages that were encrypted by the German Enigma machine. In the year 1950, Turing also published a book titled “Computer Machinery and Intelligence”, in which he proposed the Turing test of Artificial Intelligence. That test is still used by scientists. Turing test basically explains that a computer is capable of “interacting” with its user.

1939 John Atanasoff's ABC (Atanasoff Berry Computer)

Professor John Atanasoff is remembered because of his contribution of some concepts which led to the development of electronic computers. He, along with a graduate student Clifford Berry, built an electronic calculating machine that could solve the problems of equations. ABC was the first special-purpose, electronic computer.

1940 A.D. Mark-I (University of Pennsylvania – USA)

A group of scientists devised the Mark-I, which was the first electromechanical calculator in the world. It utilized the punch card concepts of Hollerith and functioned by a series of electromagnetic relays and mechanical arithmetic counters.

During World War II American Military asked Dr John Mauchy of the University of Pennsylvania to develop a machine, which could quickly calculate the trajectories for missiles. A graduated student, Presper Eckert, helped him in building the device. It is another thing that the computer could not be completed until two months after the war ended.

1943 A.D. ENIAC (Harvard University – USA)

Following closely on the heels of Mark-I, scientists of Harvard University brought out the Electronic Numerical Integrator and Calculator (ENIAC), which was the first electronic computer. It weighed nearly 5 tons and occupied space equivalent to 2 big rooms and could perform all the calculations that a small pocket calculator of today can perform. It used vacuum tubes and was able to do 300 multiplications per second. This was faster than Mark-I but the major problem of using this computer was that the staff had to rewire the machine completely for carrying out the new instructions.

1944 Mark-II (Dr Howard Aiken)

Dr Howard Aiken, who read the notes of Ada Byron, was keenly interested in constructing an “Analytical Engine”. He approached IBM. In spite of doing very well with punched card equipments, IBM hired Aiken and allocated $1 million for the research. Aiken, with his team members, came out with Mark-II. Mark-II was partly electronic and partly mechanical. It was bulky, 8 feet high and 55 feet long. It took 3 to 5 seconds to perform a single multiplication operation.

1947 A.D. EDSAC (Cambridge University–England)

Electronic Delayed Storage and Calculation was the name given to the first electronic computer in the world. It was the first one to implement the ‘stored program concept’. Known later as the ‘Von Neumann Concept’, it proposed the use of binary numbers and the internal storage of instructions in digital form.

1951 A.D. Univac-I (USA)

By now a number of commercial companies were working on the development of computing systems. Sperry Rand Corporation of USA introduced the first commercial computer to the world and named it UNIVAC-I. Its introduction was followed by the entrance of the IBM into the computer field with IBM-701 Computer.

COMPUTER GENERATIONS

In recent years, the computer industry has grown at a phenomenal pace. In a short space of 35 years or so computers have improved tremendously. In the last decade the speed of computer has increased 200 times. Not only that, the reliability curve has also taken a sharp surge ahead. The cost per unit of calculation has gone down by 500 times. The storage capacity is increasing so fast that now it seems that nothing is impossible to store. Large data can be stored in very small devices.

The term “generations” was initially introduced to distinguish between different hardware technologies. Gradually it shifted to both hardware and software as the total system consists of both of them.

Computers can be divided in five past generations, i.e., depending upon the technologies used. The five generations of computer are:

1st Generation

Until 1951, electronic computers were the exclusive possession of scientists and the military. Till then nobody tried to use them for business purposes. The idea of marketing them was conceived by Mauchly and Eckert, creators of ENIAC’s. As the US Census Bureau was already using IBCP cards, they were the pioneers in buying this computer for the first time in 1951. The company created by M and ETS became the UNIVAC division of Sperry and Corporation (later known as UNISYS).

The bringing of the first UNIVAC (Universal Automatic Computer) general-purpose electric digital computer marks the beginning of the first generation of electronic computers.

These computers used valves, and copper wires joined all the components. Due to the large size of the components and the fact that the components had to be spaced apart as the valves dissipated a lot of heat, the computers were very bulky and required huge electric power, air conditioners, maintenance and space for their installation. Further, the speed of operation was very slow and they had a very low reliability factor as vacuum tubes failed frequently. They were still given the name of “electronic brains “ by journalists. They also said that these electronic brains would change the world one day. Later IBM Corporation developed IBM 701, IBM 702 and IBM 650 and a few other systems. These were called the first generation computers. The most popular brand of first generation computers was the IBM 650, which had a magnetic drum memory and utilized punch cards for input and output. This type of computer was of intermediate size and was designed to meet the requirements of business and for scientific applications. The available memory was as much as a few hundred thousand words of main storage. The instruction-cycle time was of the order of a few milliseconds. It was only after 1957 that magnetic tapes were introduced as a faster and more convenient storage medium. A single tape could hold approximately 1100 P cards (i.e. about 2 pages of information).

IBM made 19 IBM 701 computers and at that time industry felt that these 19 computers were sufficient to take care of American business. These computer required special facilities and highly trained personnel.

The instructions given to FGC (First Generation Computers) were in machine language (i.e. 0's and 1's). As the machine language was tough and understood by very few people, there were very few personnel available.

Computers belonging to this generation had the following characteristics:

(i) Comparatively large in size as compared to present day computers

(ii) Generated lot of heat

(iii) They were not consistent and reliable as the valves tended to fail frequently

(iv) Low capacity internal storage

(v) Individual non-related models

(vi) Processors operated in the milliseconds speed range

(vii) Internal storage consisted of magnetic drum and delay lines

2nd Generation

FGC were very unreliable, mainly because of vacuum tube components, which kept on burning out. Users had to be prepared all the time with dozen of extra tubes for replacement. The computers of the Second Generation were characterized by the use of Solid State Devices (transistors) instead of vacuum tubes. Transistorized circuits were smaller in size, generated little heat, were less expensive and consumed less power than vacuum tube circuits. Despite this they were much greater in processing capacity. Since transistors had a faster switching action, this generation of computers were significantly faster and smaller, and were more reliable too, than first generation computers. The use of magnetic cores as the primary internal storage medium and the introduction of removable magnetic disc pack, were other major developments of the second generation, although magnetic tapes were still commonly used. These computers had built-in error-detecting devices and more efficient means were developed to input and to retrieve data from the computer. They were much easier to work with as compared to the earlier generation computers. More efficient programming methods and higher-level languages like FORTRAN and COBOL became available. They were easily understandable by people especially because no codes (like Assembly language) had to be remembered by the programmers. Moreover, unlike Assembly Language the high level languages were not machine specific i.e. the same set of programs could be used on computers produced by different manufactures. The instruction-cycle time dropped from several hundred micro-seconds of the first generation to tens of micro seconds. The main memory in these systems could store several hundred thousand words.

This generation of computers could communicate among each other using telephone lines. Transmission of data from one computer to another was possible in this generation of computers. Although the processing was very slow, the idea was convenient, which was further developed in subsequent generations. The problem which second-generation computers faced was that the input and output devices were far too slow. Projects were started in second generation to solve these problems. Though these were second-generation technologies, they appeared in third generation computers.

Dr Daniel Slotnick, who worked out the first solution, was working with Burroughs Corporation at that time. He designed a computer for the US Department of Defence, and tried to solve the problem of machines sitting idle, waiting for input and output. The computer known as ILLIAC-IV was developed, which had four control units, and thus was able to perform input/output and processing (mathematical operation) at the same time. Slotnick was granted a patent for "Parallel Processing". They were also called the first supercomputers. Another supercomputer was proposed at MIT (Massachusetts Institute of Technology) by a group of students and professors. The name of the project was MAC (Multiple Access Computer) and the concept of multi-programming was developed there. The system could concurrently process the various programs which were run by different users.

Some of the popular models in this generation of computer systems are IBM-1401, IBM-1620, BURROUGHS B-200 SERIES, HONEYWELL H-400, NATIONAL CASH REGISTER NCR-315, 500 and UNIVAC-1004. Many of these computers were used for business applications.

Computers of this generation had the following characteristics:

(i) Smaller in size compared to the first generation computers

(ii) Generated less amount of heat as components were much smaller in size

(iii) Greater degree of reliability because of solid-state technology

(iv) Higher capacity of internal storage

(v) Use of core storage instead of magnetic drum and delay lines

(vi) Related series of processors – the family concept

(vii) Processor operated in the microsecond speed range

(viii) High cost direct accesses storage

3^{rd} Generation

A revolution in computer development took place with the development of Integrated Circuits (IC) on a single silicon chip. In 1958, Jack St Clair Kelby and Robert Noyce invented the first IC. The IC incorporated a number of transistors and electronic circuits on a single wafer or chip of silicon. ICs are called chips because of the way they are made. They are also called semi-conductors, as they combine layers of materials that have a varying capacity to conduct electricity. This development ushered in the third generation of computer systems in 1964. The integrated circuits enhanced the processing capability, improving the speed of the computer manifold. During the period 1964 to 1970, the capability of placing 12 or more logic gates on a single chip was developed into a well-defined technology of Small Scale Integration (SSI). A logic gate is a circuit that performs arithmetic such as addition, subtraction, multiplication or division.

In 1970 this technology was redefined to a point where hundreds or more gates could be placed on a chip of silicon, and could incorporate functional logic block in an overall system. This technology was termed as Middle Scale Integration (MSI). There was intense pressure on the semi-conductor manufacturers to provide greater densities of gates on a single integrated circuit chip. Consequently, more complex chips were developed with the ultimate goal of obtaining a central processor on a single physical circuits element. These circuits had higher reliability and lower power consumption and a substantially reduced size. Component densities of 1,000 to 10,000 gates on a single silicon chip became possible. The technology consisting of 1,000 gates per chip, termed Large Scale Integration (LSI), started to become commercially viable in 1975. The later technology consisting of more than 10,000 gates per chip is called Very Large Scale Integration (VLSI) or Grand Scale Integration (GSI). These circuits became very useful in assembling computers. Some of the popular third generation computers are – IBM-360 series, IBM-370 series and ICL-2900 series. The large advanced computer systems are usually called ‘Mainframe’.

Integrated circuits technology is responsible for bringing the revolution in the computer industry. Scientists were aware that more powerful computers could be built by building more complex circuits; but as these circuits had to be wired by hand, these computers were too complex and expensive. IC solved this problem by introducing a computer that cost less than a first generation computer and offered more memory and faster processing.

In 1962, a new company built a plant in “Silicon Valley”, near Sanjose, California. DEC (Digital Equipment Corporation) revolutionized the entire computer industry with its computers, called minicomputers, which used ICs.

The first commercially available minicomputer was introduced in 1965. The PDB-8 (Programmed Data Processor) could fit easily in the corner of a room and did not require any attendant. The computer could be accessed by a number of users from different locations of the building. This was actually implementing the concept of time-sharing, which was developed in the second generation. The price of the system was one tenth of the traditional mainframe, which made it possible for smaller companies to afford.

IBM was dominant in the market by releasing 360 series of computers. They were of different sizes of mainframe computers. The main advantage of using this computer was the use of same machine language compatibility, thus making it easy and cost effective, specially when upgraded.

By 1967, IBM decided to change its track as a number of programming languages appeared in the market. This was the beginning of the software industry. As the languages grew in number and kind, people who had the skills to translate user requirements into these languages were high n demand now.

Another technological development, which took place at this point of time, was the launching of the first telecommunication satellite. The communication stations situated on earth were now in a position to send and receive data by means of satellite-enabling communication between the computer systems around the world.

Admiral Grace Nurray Hopper, also known as "the Mother of COBOL" and as "Amazing Grace", was sent to Harvard to work on the first large-scale digital computer. She attended various computer conferences and delivered lectures in various colleges about data processing insights. She wrote more than 50 papers and articles on software and programming languages.

Dr Hopper writes about the origin of Bug and Debug in her book "Understanding Computers". It was 1945; the students were working on Mark-II and it stopped working. Programmers trying to figure out what was wrong with the computer finally discovered that there was a moth caught in one of the relays which was causing the whole trouble. They removed it and the computer started working fine. There the terms "Bug" and "Debug" were introduced. The first bug can still be seen taped on a page in a logbook at the Naval Weapons Museum in DahIgren, Virginia.

Computers of this generation had the following characteristics:

(i) Smaller in size as compared to second generation computers

(ii) Higher capacity internal storage

(iii) Remote-communication facilities

(iv) Multi-programming facilities

(v) Reduced cost of direct access storage

(vi) Processors, which operate in the nanosecond speed range

(vii) Range of computers with a common architecture in which models were upward compatible

(viii) Use of high-level languages such as COBOL

(ix) Wide range of optional peripherals.

4th Generation

The decade of 1970's marked the beginning of a new generation of computers, produced by computer giants like IBM, ICL, NCR and Burrough. From the design viewpoint, the new generation provided increased input-output capability, longer component-life as well as greater system reliability. From the functional viewpoint, new powerful languages were developed to broaden the use of multi-programming and multi-processing, which brought about a major shift from batch processing to online processing as well as remote interactive processing.

The development of the microprocessor chip, which contains an entire Central Processing Unit (CPU) on a single silicon chip led to the mushrooming growth of inexpensive computers. Microprocessors are not computers by themselves but they can perform all the functions of arithmetic logic and control units of the CPU. When these microprocessors are connected with memory and input-output devices, they become microcomputers. Semi-conductor memories are also very small and very cheap. There are several types of memory chips. Three of the most commonly used are:

(i) Random Access Memory (RAM), in which data can be read or written corresponding to the main memory of the conventional computer

(ii) Read Only Memory (ROM) and

(iii) Programmable Read Only Memory (PROM).

In ROM chips, the data is 'burnt' into the chip at the time of manufacturing. It cannot be changed after that. These chips are used in systems where the data need not be changed. Even when power supply fails, the data remains in the memory. In case of PROM a user can program and even correct the data if necessary. The fourth generation of computers may be called the microcomputer generation. The input-output devices used with the fourth generation computers are quite advanced. Among the advanced input-output devices employed in fourth generation computers are optical readers, by which whole documents can be fed into the computer; audio response terminals, by which an operator can vocally introduce data or instructions; and graphic display terminals, by which an operator can feed pictures into the computer.

The use of Very Large Integrated Circuits (VLIC) has made the fourth generation (micro)computers very compact, much less expensive, faster, more reliable and with a much greater data processing capacity than equivalent third generation computers.

Some computers belonging to the fourth generation are DEC-10, STAR-1000, PDP-11 and the APPLE Series Personal Computers.

5th Generation

Till the fourth generation of computers, the major stress was on improving the hardware - from valves to transistors and then to integrated circuits - which resulted in the miniaturization and fast speed of computers. However, lack of thinking power in it forced the scientists to work further towards the fifth generation computers. The concept of "Artificial Intelligence" is being used in these computers and the Japanese call them "Knowledge Processors". Automatic programming, computational logic, pattern recognition and control of robots (robotics), the processes needing skill and intelligence are examples of Artificial Intelligence. These computers, when developed, will be able to execute billions of instructions per second and will have unimaginable storage capacities. The present day high level languages will become obsolete on these machines and new computer languages and related software will be needed.

The fifth generation gives the highest priority to making systems that are easy and natural to use. Other objectives relate to the types of technological support needed to support "problem solving systems" according to the fifth generation committee. "In these systems", the Committee adds, "Intelligence will be greatly improved to approach that of a human being. When compared to conventional systems, the man–machine interface will be closer to that of human behavior."

The fifth generation has three functional requirements:

- Easy to use computers with high intelligence and natural human input and output mechanism
- Reliable and efficient software development by new languages, new computer architectures and systems software which overcome previous problems, and
- Improved overall functions and performance aimed at making computers smaller, lighter, faster, of greater capacity, more flexible and more reliable.

These objectives set the main themes for the future of computing, whatever techniques are used to achieve them.

CLASSIFICATION OF COMPUTERS

There is a computer in the car you drive. There could be a PC on your desk or your study table at home. The weather report you get daily also involves computer, but all of them do not fall into the same category. They are different in terms of hardware, software, built, purpose and everything.

Initially computers were classified on the basis of their size, speed and cost, but now there are many more attributes attached to them.

Each and every computer must fall into one of the four categories described below:

1. Supercomputer
2. Mainframe computer
3. Minicomputer
4. Microcomputer

Whereas supercomputers are the most powerful and the largest, microcomputers are the smallest ones. Supercomputers are the most powerful computer available today. It is another thing that a microcomputer of the 21st century might be as powerful as of the supercomputer of yore. Today technology is developing so fast that it has become difficult to predict anything for the future.

Although all the above – mentioned (four) types of computers have been around for quite some time, the capabilities of each type have changed tremendously.

Supercomputers are highly sophisticated computers used for very special tasks like scientific researches, etc. Mainframes are large and expensive and are designed to meet the needs of a large organization. Minicomputers, although smaller than mainframes, are still big enough to cater to a medium sized organization or a small-scale business. PCs or microcomputers cater solely to individuals. Microcomputers could be PCs or desktops or laptops or even notebooks. The computers around us, like those in microwave ovens, washing machines, automobiles, etc., are embedded computers, which are special-purpose and are generally used to perform control functions.

Supercomputers

These are the most powerful computers designed till now. They are made to process huge amounts of data. Many users can access them at the same time. They are primarily used for mathematically intensive scientific researches such as in aerospace, satellite, chemical, electronics, petroleum and nuclear power industries. Supercomputers are used in weather forecasts. It would not have been possible to warn the people around the coastal areas about the advent of a hurricane but for a supercomputer. It is because of supercomputers alone that such a large-scale devastation can be controlled well in time saving human lives as well as financial and infrastructural resources.

Supercomputers are also found in public, private and government research centers such as universities, government labs and R&D departments of organizations.

One main area where supercomputers are used is in the nuclear field, especially when nuclear fissionable material approaches a critical mass, and researchers are required to know what is happening at every nanosecond of the nuclear chain reaction. A supercomputer can monitor the actions and reactions of million of atoms when they interact.

Supercomputers were used to find out the pollution in Los Angeles. The model comprised of more than 5,00,000 variables including geographic elevation, temperature, airborne chemicals, etc., and it was required to create an accurate simulation of the Los Angeles Basin to decide upon various strategies to be used to control air pollution. This would have taken months with less powerful computers, but supercomputers did it in just half an hour.

The first supercomputer was built in the 1960's for the US Department of Defense. That was supposed to be the fastest and most powerful computer of that time. Millions of dollars are being spent on R&D of the technology enhancement of supercomputers.

The main feature of a supercomputer is multiprocessing, which enables the computer to perform a large number of operations simultaneously. The first supercomputer had 4 CPUs. Today's supercomputers have hundreds of processors. The speed of the supercomputer is measured in Nanoseconds and Gigaflops. A Nanosecond equals 10^{-9}th of a second and a Gigaflop is 1 billion floating-point arithmetic operation per second. A supercomputer can perform up to 128 Gigaflops.

Market and R&D leaders of supercomputers include IBM, Silicon Graphics, Cray Research Corporation, Fuifits, Intel, Thinking Machines, etc.

Thinking Machines has produced a supercomputer called Connection Machine, which has over 64,000 processors. Its price is about $5million. Supercomputers are priced from $2million to $20million and they consume electricity enough to light about 100 homes.

Mainframes

Mainframe computers are used where many people in a large organization need frequent access to the same information, which is usually organized information of one or more large databases.

After UNIVAC-I was sold in 1951, the mainframes caught the attention of the computer industry. IBM, the computer giant, captured the mainframes market in the late 1950's and made their name and money in the mainframe market. A mainframe computer system is generally made up of several computers, called terminals, in addition to the mainframe or host processor. A terminal is a keyboard and a screen wired to the mainframe. It does not necessarily have its own CPU or storage it just has input and output devices that function as the windows of the computer placed elsewhere. The host processor is responsible for controlling rest of the processors, operations and the peripheral devices attached to it. A front-end processor is the one that handles communication to and from all the remote terminals connected to the computer system. At times, a backend processor is also used to the handle data retrieval operation. Although the host computer is capable of doing all the operations by itself, it is still better to have two processors to share the load, thereby saving time and increasing speed.

The mainframe computer has a processor that handles input, controls the database and output needs of the terminals attached to it. Each user has access to the contents of the database. It is difficult to store such massive amount of data and it would also be too slow. Many modern mainframes have multiprocessing capabilities. However, they are generally limited to 8 or less processors. They are slower than supercomputers and their speed is measured in megaflops and not in gigaflops.

Mainframes can cost anything above $35,000. It used to be common for mainframe computers to occupy an entire room or even an entire floor of a high-rise building. Typically, they were placed inside glass offices with special air conditioning support to keep them cool, and on raised floors to accommodate all the wiring needed to tie the systems together. This setup is not used anymore. Mainframes today, look more like a file cabinet although they still need the same type of environment.

A mainframes can support up to several hundred users simultaneously. It does so by keeping a number of programs in primary memory and by rapidly switching back and forth between programs. These operations are so fast that users do not even come to know that it is working on others tasks. This property of processing many tasks concurrently for multiple users is called “multiprogramming”.

No one really knows from where the term 'mainframe' originated. Earlier IBM documents define the term frame as an integral part of a computer: “the housing …. hardware support structures, …. and all the parts and components therein”. It was only when computers of various sizes and shapes came into existence, that the big computers began to be referred to as main frames and eventually became one word 'mainframe'.

Minicomputers

The advent of minicomputers or minis as they are sometimes called started in the 1960’s when DEC (Digital Equipment Corporation) began shipping its PDP series computers. The press named them minicomputers because of their small size as compared to other prevailing computers.

The easiest way to describe minicomputers is by saying that they lie somewhere in between mainframes and microcomputers. They can handle a great amount of data like mainframes. They can also support a number of terminals just as mainframes do. Although they are designed for hundreds of terminals, they differ in speed, i.e. minicomputers are slower than mainframes and they cannot support as many terminals as mainframes can. They have less storage capacity and their printers too are slow. They are meant for smaller organizations, which can neither afford mainframes nor do they require such big computers. The cost ranges from $18,000 to $50,000. The major manufactures of minicomputers are DEC, Data General, IBM and Hewlett Packard.

Workstations and Microcomputers

When working on minicomputers and mainframes through terminals, users can just control the input and output of the computer. Whereas a single user computer gives you the power of controlling the total processing cycle i.e. input and output, processing and storage. You can select your own programs and do not need to be dependent on mainframes or minis for storage. They are designed to meet the needs of an individual and thus are also called as Personal Computers. PC and microcomputers are interchangeable as far as meaning is concerned.

When we talk about computers today, we generally mean a PC or a microcomputer. Microcomputers have a great impact on the computer industry. Till 1975, they did not even exist, and in 1995 the sale of PCs was as high as $16 billion. Microcomputers are the fastest growing segment of the computer industry. One of the sources of the PC's popularity is the rate at which improvements are being made in the technology. As the technology is growing, microprocessor, memory, chips and storage devices keep getting faster and better and bigger. Today, a typical PC has 8 times as much RAM, 150 times more storage capacity and a microprocessor that is at least 100 times faster than a PC 10 years earlier. Analysts believe that the pace of this growth will be the same for another 20 years.

In 1981, IBM called its first microcomputer the IBM-PC. Within a few years there were many more companies in the race to design a computer compatible to IBM-PC. Thus the term IBM-PC became the name of a family of computer that included IBMs and IBM compatibles. The vast majority of computers falls in this family except Apple Macintosh, which is another family of microcomputers made by Apple Computer. It is appropriate to say that Macintosh is a personal computer but not a PC. Presently IBM commands over about 28 percent of the market where as Apple holds about 8 percent of market share.

A few years ago, Apple Computers, IBM and Motorola joined to develop the Power PC chip, which enables Apple Computer to run IBM applications and vice versa. Most Apple Macintosh computers and compatibles are based on this chip.

A single computer can actually fall into the category of either a microcomputer or a workstation. A workstation is a powerful desktop computer designed to meet the computing needs of engineers, architects and other professionals, who need graphic display. Workstations are generally used for CAD (Computer Aided Design) applications. For this type of complex programs the computer needs great processing power and much storage. They are also used as services for LANs (Local Area Networks). Workstations are sometimes called “Supermicros”. Although they look like desktops, the chip inside is different. Most workstations use RISC (Reduce Instruction Set Computer) microprocessors. RISC processors are used in special purpose applications, where speed is critical.

Presently the boundary between workstations and PCs is becoming less distinct. Today’s PCs are better than workstations of the past. Pentium-pro has multiprocessing capabilities. Most microcomputers support multitasking (enabling the user to switch between the tasks). Multitasking saves a lot of time. The user can open another activity while one task is being processed. For example while the computer is downloading one thing in the browser, the user can open another window for writing a mail or a calculator to perform some calculation.

One style of PC is the desktop. This type of computer is small enough to fit on a desk but is too big to carry around. There are a number of models available in the desktop category. The cabinets come in flat (horizontal) and vertical (tower model) depending upon the space management of the user.

Laptop Computers

The first portable computers were known as “luggable”. They weighed about 28 pounds. As the size reduced further the term also changed to “laptop”. Laptops weigh about 10 to 12 pounds. The name was probably given because laptops are kept on the laps while users are on the move (in a car, an airplane or train).

Notebook Computers

As the name suggests, their size is about 8.5 by 11 by 2 inches, and can easily fit inside a briefcase. They were initially called laptops too, but gradually as the size decreased even further they started being called notebooks. They can be operated on batteries also. They are fully functional microcomputers. They can have input devices Hard Disk Drives, Floppy Disk Drives, a CD-ROM, a modem and an in-built mouse.

Personal Digital Assistants (PDA)

These are the smallest portable computers and are no bigger than chequebooks. They are also called palmtops. They are not as powerful as notebooks and laptops. They are used for some special applications like keeping record of phone numbers, dates, agendas and calculations. They can be connected to large computers to exchange data. They also come with an electronic pen, called stylus, that lets users write on a touch-sensitive screen. The latest PDA's can use infrared light to communicate with nearby computers. They may also have built-in capabilities for fax, cellular telephony and e-mails.

These are meant for the people who want to avoid carrying a lot of weight and do not need the full collection of applications while away from home or office. These computers use inexpensive batteries. They do not have any disk drivers. They use the PC card, a card of the size of a credit card, to store programs and data. Notebook and desktop computers also have now adopted these PC cards. PC cards are some version of smart cards (small cards developed in France). They were earlier used to pay highway tolls, make STD calls, pay bills etc. A smart card has a microprocessor and a memory chip.

Embedded Computers

Have you ever noticed that computers surrounds you everywhere? Be it your car, your kitchen, bathroom, entertainment or anywhere else. You start using computers the time you get up in the morning and keep using it till you go off to sleep. Such computers as these, which work inside other machines, are called embedded computers.

Cars use embedded computer to control the engine. Alarm clocks use these computers to wake you up. VCR and TVs also use embedded computers for a variety of functions. The users do not even realize, while using these equipment, that they are using embedded computers.

CHARACTERISTICS OF COMPUTERS

A few notable features of computers are:

Speed

The computer was initially invented as a very high-speed calculator. It helped in completing many scientific projects that were previously impossible. The landing on the moon would not have been possible if computers had not been there, neither would we today take an umbrella, if saw a clear sky, if the weather, forecast did not tell us that it would rain in the afternoon. We would have taken a lot of time in making the arrangements for flying abroad if computers were not there to book our seats so easily and fast. The ability to get the answers fast enough so that one has time to take an action on them (to make alternative arrangements in case of reservations) makes real time computing possible. Electrical pulses travel at incredible speed and a computer, an electronic machine, works on electrical pulses, so its speed is virtually instantaneous. When talking about the speed of computers, we don't talk in seconds or microseconds but in nanoseconds (10^{-9} seconds) or even Pico seconds (10^{-17} seconds). You can very well imagine the speed of computer by the fact that a computer can add two 18-digit numbers in 300 to 400 nanoseconds: that means that it can do about 3 million such calculations per second.

Storage

The human mind acquires some knowledge and after it has used it, it might keep it in its subconscious mind or might even forget it after some time. But computers can store massive amounts of information. This information can be used and reused time and again for years (unless something goes wrong with the hardware). Today's computers have disks with a capacity of storing billions of characters. This is big enough to store the complete Britannica thesaurus, dozens of computer programs or the applications, thousands of songs, huge databases, all the projects we have ever done in our life and much more.

Accuracy

Computers are very accurate. They do make mistakes, but seldom. This is because of their physical circuit. They make mistakes because of faulty programs, some mistake made while feeding in the data or poor designing. Highly efficient error detecting techniques of computers prevent showing false results.

Versatility

Computers are capable of performing any type of task, provided the activity can be put into logical steps. It can be used from cooking (microwave oven) to spending a night on the moon (through satellites). In today's world it is difficult to imagine even a single field which is untouched by computer invasion.

Automation

A computer is much more than just a calculator in which we need to give the instructions at every step. It is an intelligent device and, if programmed for an activity, it keeps doing it till it finishes, without any human intervention.

Diligence

A computer, being a machine, does not show any signs of fatigue, tiredness, lack of concentration, or loss in interest. The speed, accuracy and the quality would be absolutely the same in the first and the last calculation, even if the computer does millions of calculations. It won't complain even once of boredom. Thus, it is best suited for monotonous and voluminous work although that may seem like a threat to the people who are working on the same kind of jobs.

Reliability

All the above qualities of computers make them reliable and also make us too dependent on them. They can be run for years and years without any loss of data or facing any other problem.

Although computers can potentially solve all the problems when instructed appropriately, they are not creative. They are designed and run by humans only. They might make an exact copy of Picaso's paintings but actually can not give the world their original creations. They might print out countless copies of Shakespeare's Hamlet but can never write anything on their own. They might replicate the Taj Mahal but will never be able to produce architecture like that on their own. And we must be happy about that as we humans still are superior to computers.

DISADVANTAGES OF COMPUTERS

Until now we have discussed the good points of computers like making work easier, reducing the response time, facilitating the daily activities, dealing with large amounts of data and many more, but there are some bad effects too attached to computers. Some of the disadvantages include the following:

1. They are manufactured using hazardous chemicals that can harm the health of users, as also contributing to pollution.
2. They are failure prone. A failure in a nuclear power station, or airplane etc. can endanger many lives and resources.
3. Discarded computers are real junk and consume lots of space.
4. They are always a threat to personal privacy.
5. Working longer on computers gives the user back pain, nerve injuries etc.
6. Because of the automation brought about by computers, unemployment is on the rise.

TASKS ASSOCIATED WITH COMPUTERS: THE MULTIPURPOSE TOOL

In the 1950's computers were special purpose machines that could cater to only governments or huge industries due to their high cost. Initially they were being used only to perform complex numerical problems such as these required in astronomy, statistics, processing, for the Bureau of Census or deciding the trajectory of missiles.

In the 1960's, modern computers brought about a revolution around the world. In 1964, IBM brought its system—the 360 mainframe computer—into the market and sold about 33 thousand of these machines. After this grand success, IBM became a standard for computer manufacturers.

In early the 1970's, DEC (Digital Equipment Corporation) took a step ahead by introducing its PDP-II and VAX computers. These catered to various segments. Modern computers were of different sizes and prices. That was the time when computers started shrinking in size. Today's personal computers or PCs, which are much smaller than those earlier computers, provide much power to the user and are inexpensive too.

Business

Computers have become such an integral part of our lives that we use them day and night. They have become such an important part of our business that it is difficult to think about life without them. From typing a letter to taking out the balance sheets of a company and designing a building, the computer is present everywhere. Today, in the offices of any industry, you will see computers on every desk, from the receptionist's table to the CEO's desk.

Clerical staff use it for writing letters, to keep a record of their day-to-day expenses and administrative work, sales people carry laptops and notebooks to transmit information from anywhere in the field or to give their presentations. Accounting departments of every organization use them for manipulating and playing with the figures and numbers, taking out budgets, analyzing financial records and keeping track of the profits and losses of the company whereas the department keeps track of the leaves, resume(s) and any other information of the employees of the organization.

You can see a computer when you go to buy grocery, or to a bank, or to make an inquiry about a flight, or to take out money from an ATM or to get a prescription from a doctor, or any other thing you can think of.

Medicine and Health Care

In the health care industry, computers are very useful. They are used for diagnosing the illness of a patient, performing surgeries and even controlling the robots that work as assistants to the doctors.

Not only this, many small special purpose computers are placed inside the body of a patient for performing specific tasks (such as pacemakers). Artificial internal organs are commonly used nowadays to replace defective organs inside the body. Computers can be used to see internal hemorrhages or clots without even putting a cut on the human body. Now, some computers are so tiny that they are swallowed to take and transmit photographs of very dense parts of the human body. In this way they act as wonderful diagnostic tools.

Now, laser surgery is performed without even a cut on the human body while everything it monitored on screens. This kind of bloodless surgery can only be performed because of computers. Accuracy and efficiency has increased tremendously and the rate of successful operations has also risen sharply.

Education

Computers have brought about a revolution in the education industry too. They are present in classrooms, libraries, laboratories and museums. Even a child of three years of age uses them.

For young children, self-learning tutorials are so interesting that they start doing them before they start going to school. Most important is that all age groups can use them, i.e. from a child to very senior or old people.

The concept of paperless libraries is spreading very fast. This means that there is not a single book in the library. Only computers are present. Students can go to these libraries and enter the name of the book they want to read and the contents of the book appears on screen.

In museums, computers help visitors by telling them about exhibits. Detailed textual, audio and video information is available on computers and human guides are not used any more.

Students prepare their project reports, presentations and even their notes on computers. Today, small kids prefer doing their homework on PCs. In the USA, most universities require assignments to be submitted on computer. No paper sheets or hand written assignments are allowed.

Computers are very commonly used as interactive tools. They are used for teaching, testing, re-teaching and retesting, to make sure that the student understands a topic as per his mental level and caliber.

Encyclopedias nowadays come in the form of CDs and are very helpful. One doesn't need to go and search in the huge and heavy Britannica. Not only this, most magazines, journals and newspapers are available in soft copies and the records of past decades are also stored in very less space.

Science

It would have been almost impossible to explore this world, specially the solar system, so intricately without the help of computers. It would have also been difficult to predict natural calamities like earthquakes, hurricanes, volcanoes, etc., and warn people beforehand so that safety measures could be taken well in time.

Scientists collect, test, transmit, analyze and exchange information electronically to widen the scope of research and bring in more accuracy. This way they can estimate the impact of an expected natural calamity so that precautions are taken against them.

A man stepped on the moon and the whole world watched his activities on their TV sets through satellites (again, thanks to the computer!). Now, satellites and spacecrafts are launched and computers monitor their activities without any human intervention.

Engineering

An electronic engineer designing chips manually would obviously be less productive than if he designs the same on PCs. Similarly, an architect can create the best design by matching the few options available to him. If, while designing, a number of views are to be seen, manually one has to draw that many number of drawing or figures describing each view separately, whereas the computer can give him access to the same figure from various angles, thus preventing the tedious, error prone and boring job of making the same drawings again and again.

One of the most extensive uses of computers is CAD (Computer Aided Design). It helps the engineers tremendously in designing the aircrafts, missiles or even small airplanes. It not only saves time but also physical effort. One more advantage of designing with the help of CAD is that it saves a lot of money in designing and redesigning the parts of expensive mobiles.

CAE (Computer Aided Engineering) goes one step further. It helps designers to specify even the type of material to be used in respective parts and to estimate whether the part will be able to withstand the required stresses and temperatures. This type of testing is a very critical part of the total designing of planes.

Manufacturing

The use of computers is not restricted to just the field of designing; but is being increasingly extended into the manufacturing sector as well. Be it in generating power, in manufacturing automobiles or even doing some embroidery work on a piece of cloth, the computer literally controls everything. Just some settings are required, and it not only functions smoothly but also gives warning signals (if required). And when needed, it sometimes takes appropriate action as well.

For all those electricity-generating machines, computers control power production. These are special purpose computers. They not only monitor but also regulate the temperature and pressure inside and outside the boilers. If they are not able to control something at some critical point, they set the alarm/warning bells ringing, so that somebody can just come and check. It is so convenient and safe that now all the electricity-generating stations are fully automated and computerized. Apart from the ease of the work, they reduce the chances of any mishap.

They also help a lot in the industries where the work is hazardous for humans. There computerized robots get in! They do the work like welding, painting, and cutting in steel industries, and also in industries where there is work that involves acidic elements that are very bad for health. The robots are fully computerized and this type of manufacturing is called CAM (Computer Aided Manufacturing). Now it is being called CIM (Computer Integrated Manufacturing) meaning computers can be used to control the entire production process, right from designing to manufacturing.

Computers are also used in automated fabrication in the garment industry, and are involved in activities ranging from cutting the fabric to stitching buttons on the finished garment. Not only this, they are used in customized tailoring, meaning that the size and measurements of the customer are fed into the computer. The computer then gives instructions to the various machines attached to it and the best-fit clothes are ready for the customer! Computers are also used in embroidery machines. A design is fed into the computer and it is embroidered by it automatically with the colors of threads specified by you. Modifications can also be made in the pre-designed patterns and thus, a customized product can be manufactured.

Legal Practices

Just imagine a lawyer mugging up all the acts and sections of the law or even going through them to find out what is required. It is not only difficult but also error prone. On the other hand, think about the same lawyer feeding in the details of the case in the computer and getting a list of all the acts and sections or, even more specifically, the exact act and section applying to that case. The difference is amazing!

Today all those law books are already fed into the computer for quick references. Such databases are very helpful for easy and quick work, which has actually helped in reducing the research time from hours to microseconds.

Such use of computers is available not only to individual lawyers, CAs or attorneys but also in a courtroom where the stenographer's text is immediately transformed into readable text, and the decision taken by the magistrate can not only stored in the computer but can also be transmitted across the country for easy reference.

Lawyers have also started carrying laptops to the courtroom for the details of the case they are fighting, thus contributing to building a paperless office.

Government

The government also makes extensive use of computers in its work. It has started making a database regarding childbirths, deaths, income taxes, any other taxes etc.

Government Passport Services are also online, which means passport forms can be downloaded, and even filled and submitted online sitting at home.

The campaigning for the elections is also done online nowadays. The time is not far when the entire electorate will vote directly online, when people will fill up their income tax forms online, and the entire database of each citizen of the country will be computerized, thus improving the government's efficiency.

Law Enforcement

Computers help many departments like the police or the crime branch to function more efficiently. In America, there are MDTs (Mobile Data Terminals) in which a police squad simultaneously calls all computers, which have data regarding the car numbers, persons who own those cars, their license numbers, whether they have valid license or if the detained person was issued a warrant etc. The computer notes down the number of the car (of the person violating the rule or the law) and then provides all the above-specified information to the constabulary. This not only makes the process faster but also reduces the hassle of calling up the department and collecting the same information from various places. Thus with MDT's help, the police perform their duties efficiently, effectively and on time.

Similarly, the DNA technique is very popular in the crime branch where fingerprints are used to get all the information about the criminal or the person concerned. A very simple cue about a criminal can be used to draw the exact picture of the person with the help of a computer.

Defence

In the mid 1940's the first large scale computer ever developed was created for the Army of US - ENIAC (Electronics Numbered Integrator and Calculators). It required a house to fit in, occupied space as big as 1800 square feet and contained about 18,000 vacuum tubes. It was initially designed to compute internal shell trajectories for various distances and weather conditions.

Now computers are used in airplanes, fighter planes, submarines, on the battlefields in weapons and satellites, in one way or the other.

The army, uses it in its Human Resources Department, considered the biggest organization in the world. Computers are used to communicate by radio in air, under water and on surface with a land based network that is used to integrate the systems.

Computer nowadays are also used as Smart Bombs, which are actually missiles but don't look like that.

Music

Computers are a great help to the musicians as well. They not only compose their tunes and music on computer but can also use them to find out the best setting automatically. The MIDI (Musical Instrument Digital Interface) is very commonly used for synchronizing hardware and software, to produce electronic notes.

A musician can touch one synthesizer key for producing the sound of an accord, and another for the sound of the tabla. Not only that, the computer also translates the music into text form or musical notes automatically.

Various settings of different instruments can be tested independently and then can also be combined together to get the best possible output. It enables the fine editing to add music and sound effects to human speech and vice versa, thus getting best possible result of complex compositions and their synchronization with the instruments.

Theatre, Film and Television

Have you ever noticed the computer's contribution to the serials you see on the TV, the advertisements that children watch with such great interest or the movies you see in the cinema halls? All these owe a lot to computers for the improvement in the performance and inculcation of special effects, which have a great impact on the audiences. Even in theatres, the use of computers has become a very normal phenomenon.

In theatres the lighting system is totally computerized and the effects of light are coordinated and controlled automatically as per the demand of the situation. Artists even use some images and sounds to improve upon the performances. This not only enhances the enjoyment but also leaves a deep impact on the minds of the audience. Virtual images are shown dancing on the floor, which actually is nothing in reality.

In movies also, fictitious characters are made to do whatever is wished from them. Sometimes they are even made to work as actual live actors and actress. The characters are animated as needed. For example, the dinosaurs of “Jurassic Park” were a masterpiece of computer creation.

At Home

If computers are used everywhere how can homes be left untouched? Apart from PC's, most of the computers that we use are generally hidden, which means that they are embedded in household appliances. For example, the microwave oven which warms our dinner and even switches off automatically after the job is done, has a computer embedded in it. Similarly our TV has an embedded computer, which automatically tunes the image brightness and sound as per the surroundings.

Washing machines, sewing machines etc. also use computers for running faster and more efficiently. Mummy prepares the monthly budget, Papa makes a database of his meetings, addresses and schedules, and sons/daughters do their homework or play games on the PC. Grandpa tries his hand at a game of chess with the computer and grandma researches recipes for the kids.

Internet

The field of communication is another area where the use of computers has greater enhanced its efficiency and made it cheaper too. The Internet is a World Wide Network of computers that connects the people together and reduces the distances. It can be used for receiving, sending and sharing information.

ELEMENTS OF A COMPUTER

The computers about which we have been discussing come in all shapes and sizes and can be used for various purposes. But all of them have certain characteristics in common. Two of the most important constituents of computers are — hardware and software.

Apart from these two main elements of the computer, i.e. hardware, which represent the physical parts of the computer, and software that represents the programs that instruct the computer what is to be done, computers also include processing. Processing transforms data into information and involves data, people and procedures. Thus all these together are the five elements of the computing process (as a whole). These five elements are:

1. Hardware
2. Software
3. Data
4. People
5. Procedures

But all these elements have to be organized in such a way that each element works smoothly and efficiently, both individually and in coordination with others. During the computing process, computers integrate all these five elements.

Thus we can say that the computing process includes everything and everybody necessary to accomplish an activity or to perform a task. All the five elements of computing process are explained below in detail.

Hardware

The term hardware refers to the physical parts of the computer or includes anything in the computer that we can touch. It consists of interconnected electronic device that control everything in the computer.

Hardware can be divided into four major categories. They are:

1. Processor
2. Memory
3. Input and Output Devices
4. Storage Devices

Processor

The complex procedure that transforms data into information (useful and meaningful data) is called processing. This type of transformation mainly includes two components —the processor and the memory.

The Processor acts like the brain of the computer. It organizes and carries out the instructions given to the computer by the user or the message passed on by the software. There are various types of processors available in the market. In PC, we use microprocessor(s) (a number of microprocessors can also be used in one PC), Microprocessors are made of silicon or some other material and are etched with many tiny electronic circuits. The microprocessor is plugged into the circuit board – a hard rectangular board that contains the total circuitry used to connect the processor to the rest of the hardware. This circuit board is called the motherboard. The number of chips and circuit boards (on which the processors are plugged in) is increased when the computer is to be made more powerful. The term Central Processing Unit (CPU), in real terms, is the processor of the computer. This "brain" of the computer, without which nothing can be done is very small in size and occupies just a few square inches of space.

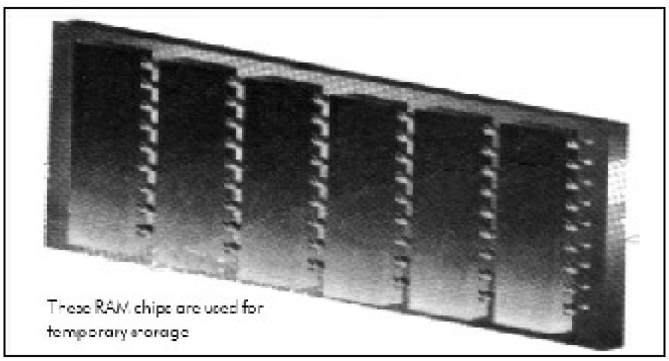


Figure 1.3

Memory

The software is loaded into the memory of the computer and runs from there only. Not only the software or programs, but also all the data is loaded into the memory for easy access. This memory is called as RANDOM ACCESS MEMORY (RAM). When one talks about memory one often means RAM only.

The main thing to be kept in mind while working on the computer is that RAM is a volatile memory and every things disappears if power goes off or is turned off abruptly in the middle of work. Thus, it is always advisable to frequently save the work on the storage disk while you are working.

The amount of RAM in a computer tremendously affects the speed and power of the computer. The more the RAM, the greater is the power and speed of the computer. The measurement unit of memory is byte. The bigger units of bytes are:

Kilobyte (KB) ~ 1000 bytes [2^{10} bytes = 1024 bytes to be precise]

Megabyte (MB)~ 1000 KB ~ 10,00,000 bytes

Gigabytes (GB)~ 1000MB ~ 10 ‘KB ~ 10’ bytes

Nowadays PC’s have 8 to 128 MB of RAM.

ROM

Read Only Memory holds permanent data or instruction that can only be read, and nothing can be written on it. Information is permanently recorded in it. It is nonvolatile memory. ROM contains instructions to get the computer started when it is switched on. It also holds instructions for the control of the various peripheral units of the computer, such as graphic display, disk drive etc. The controls of ROM are built into it at the time of its manufacturing.

Input and Output Devices

The computer accepts the instructions and delivers the results to the user by means of some devices. There are two main types of devices. Input devices are used to enter the instructions whereas output devices are used to see the results of processing. The term device is generically used to refer to any piece of hardware.

Thus, input devices accept the instructions or the data from the user and output devices return the processed data back to the user in the form of visual display or on paper. New types of input devices keep on coming as technology and the users' demands grow. The most commonly used input device is the Keyboard, which accepts numbers, alphabets and commands from the user. Another input device is the Mouse that works with the action of a click or by moving. The diagrams or some drawing is made on the screen by pressing its button and moving it on the surface. Even the commands are executed by clicking it on the commands displayed on the screen. The other commonly used input devices are trackballs, joysticks, scanners, lightpens, microphones, digital cameras etc. These will be discussed in detail later.

Both the Mouse and the Trackball are used almost in the same way. Both of them allow one to draw or to execute some action on the screen by a click. The Joystick is generally used to play videogames. A scanner is used as a photocopying machine. It copies the photographs, drawings or the text as it is into the computer memory, thus saving time of drawing or keying in manually.

Lightpen is used to directly draw the figures on the screen of the monitor. Microphones help in inputting our voice directly in the computer or inputting music from CDs or audiocassettes by attaching them to the computer. Digital Cameras are used to bring in live images onto the screen, where some changes can also be made thereon. They are generally used in the barber’s shops (to see the best hairstyle that suits the customer) or in the optical shops etc.

The output devices are used to see the results of processed input. The title case output devices mainly used are the screen or VDU (Visual Display Unit) and the Printers. When the soft copy of the output is required it is seen on the screen of the monitor and if hard copy (on paper) is required, then the computer sends it to the printer. Apart from these two output devices, Speakers can also be used as output devices to produce sound, listen to audio CDs or music.

There are some more devices that act as both input and output devices. One such device is the Touch Screen which is a type of monitor that displays virtual buttons which you can touch.

Modem is an example of a communication device that is used to communicate through telephone lines. It performs both the functions. It is used to interconnect the computers. The process of interconnecting the computers is called networking. The network interface cards are used to connect the input of computers so as to share the data and the devices.

Storage Devices

Although the computer can be said to be complete with input and output devices, memory and CPU, and can function quite well, but when it comes to the need of storing data or even programs files for future use, some place is required to store them. Storage devices are used to store data permanently or semi-permanently.

Storage holds the data and the software brings into the memory (RAM) a particular program or data required at that point of time. After you have finished with the work, you again put back the programs and data (new one or processed) into the storage.

Storage can be differentiated from memory thus:

1. Storage is cheaper than memory
2. Storage has more space than RAM
3. Storage is not volatile whereas RAM is, i.e. data remains in the storage even if the power is switched off unlike RAM
4. RAM is faster than storage.

The most widely used storage medium is the magnetic disk, which is round in shape and flat. Read and write heads (similar to the heads of cassette players or VCRs) float above and below the disk near the surface. The disk spins around their center.

The device, which holds the disk, is called a disk drive. There are some drives which have built-in disks and these disks cannot be detached from them, whereas some drives are meant for removable/replaceable disks. Almost every PC uses non-removable disks, but additional removable diskette drives can also be used. The non-removable drive is the Hard Disk Drive (HDD) and the removable one is the Floppy Disk Drive (FDD). A computer can have any number of HDDs and FDDs as per the user's requirements.

HDD can store far more data than a diskette can, so the HDD serves as the computer's primary filling cabinet. Diskettes are used to load new programs or data on to the HDD to transport the data or make the backup copies of the data of the HDD.

The floppy diskette or the removable disks are made of plastic, and, to protect them from dust and scratches, are kept enclosed in vinyl cases. Initially, floppies measured 8 inches; they were reduced to 5¼ inches and now we use 3½ inches diskettes. The size of diskettes is decreasing in diameter, but its storage size is increasing. The capacity of the 8" diskette was 360KB, and that of the 5½ inch was 1.2 MB, whereas the 3-½ inch diskette stores 1.44MB of data. The name floppy was given because the vinyl cover (on 8” and 5" diskettes) used to be very flimsy or floppy.

Other types of storage devices include CD-ROM drives, tape drives, optical drives etc. CD-ROM is the most popular type of drive after Hard Disk Drives and Floppy Drives. Compact Disks are optical storage devices similar to audio CDs and can store approximately 640MB. In personal computers we generally use CD-ROM (Compact Disk Read Only Memory). The information on CD-ROM cannot be changed.

Since new writable CDs have come into the market, it has become very convenient to store large amount of data, making it easy to transport.

Software

Software brings life into the computer. It is nothing but instructions (or a program) required to run the computer. It guides the hardware on how to do its job. A computer is otherwise a general-purpose machine. It is the software which differentiates the various kinds of jobs a computer can perform. Software consists of electronic instructions. A specific set of instructions that drive a computer to perform a specific task is called a program. When a computer is using a particular program, it is said to be running or executing that program.

Programming Language

Software programs are written in programming language and the programmers are the people trained in the use of a programming language to write the programs.

Before the 1950's the only language available to the programmers was machine language or low-level language. A machine language was recognized by only one type of computer processor. Machine language is the only thing that computers understand but for programmers such machine language was very difficult to understand use and develop programs. In 1952, assembly language was introduced, which again was a low-level programming language. In assembly language short codes were used for specific machine operations. A specially designed program called assembler, was used to translate these codes to machine language, so that the computer was able to carry out the programmer's instructions. Assembly language was easier than machine language, but it was still difficult in itself, as the programmer had to remember a large number of codes. Moreover, the programmer had to have the knowledge of the working of the computer.

Then, in the 1960's, high level programming language came into existence. It was (and is) comparatively easy to use, as it understands simple English words and mathematical expressions. The programmers do not need to memorize the details of the working of the computer.

Although the number of programs available is large and varied, software can be classified mainly into two categories:

1. System software

2. Application Software

Computer literacy involves learning the use of both system and application softwares.

System Software

One main type of system software is the operating system that is required by the computer to function. System software integrates the computer hardware components, and also provides the tools to use the software components in the desired manner and for the day-to-day maintenance tasks like displaying the list of all the directories and files on the disk.

Operating System

When the computer is switched on, it takes several steps to prepare itself for use. The first step is a self-test, i.e. it identifies all the hardware devices that are attached to it and whether the memory is functioning properly or not. This routine test is initiated by a part of the system software located in Read Only Memory (ROM), i.e. a chip that contains brief permanent instructions for getting the computer started. Next, the computer looks in the diskette drive and then in the hard drive for a special program, i.e. operating system. This system tells the computer how to use the hardware devices such as the disk drive, keyboard, and monitor and how to interact with the users. When the computer finally finds the operating system it loads it into the RAM. It remains there till the computer is switched off.

After the loading of the operating system, the computer is ready to accept the commands and instructions from the input device. There are different types of operating systems that are commonly used, such as MS DOS (Microsoft Disk Operating System), Microsoft Win95, Microsoft Win98, Microsoft Win NT, Macintosh operating system, Linux etc.

Application Software

It is the software which turns the computer into a tool for doing some specific tasks. These are the programs, which cater to various needs of the users. Application software is written for every type of task, i.e. from word processing to collecting information on the worldwide web.

The complex programs, such as any word processing package (MS WORD), consist of many separate programs that are designed to run together. Such a collection of software programs is known as a software package.

Application software can further be classified into:

(a) Special Purpose Application Software

(b) General Purpose Application Software

Special Purpose Application Software

They are used to perform a specific task, say for a single profession, e.g. nuclear energy scientists use special programs for exploding the nuclear bombs. If a person has no knowledge about the subject, he won't find it useful or interesting to learn.

General Purpose Application Software

These are the other type of application software used by millions of people for doing varied tasks. Commonly used General Purpose softwares are:

Word Processing: We can say that the word processing programs are computerized typewriters. The difference is of the facilities available in the package. Editing in the text files is easy, spellings and grammar can be checked, and diagrams, figure, labels can be inserted very easily. It has become a very handy tool for writing books and as editing is done very conveniently thereon. All the legal documents and encyclopedia etc are typed on to the computer for easy reference. It also prevents wear and tear.

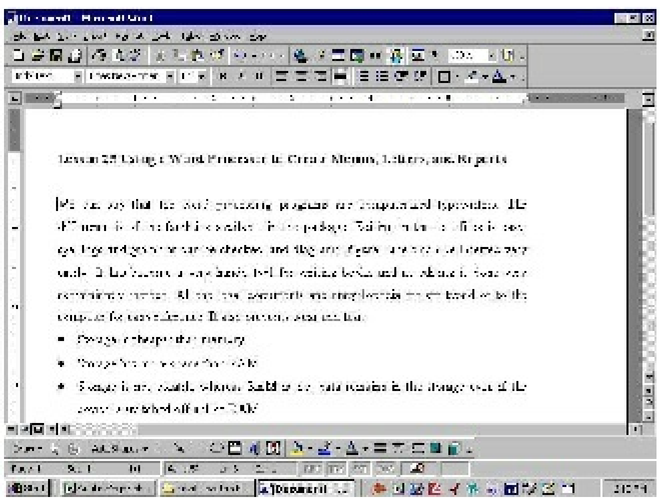


Figure 1.4: Word Processing using Microsoft Word

Desktop Publishing: Although most of the word processors have the facility of desktop publishing, these specially designed programs are very helpful in designing newsletters, magazines etc. Earlier it used to be a tedious task as it involved time consuming activities like cutting the papers, photographs, border designing and then pasting them to create an effective layout, but now it has not only become convenient but also gives a better and more pleasing layout. The attractive results can be taken out and this needs very little training and practice. Business organizations and media use DTP to design their advertisements and catalogues. Even the books that include creative graphs are taken out by using DTP. DTP produces output that is a combination of word processing and graphics, resulting in professional looking papers ready for printing. One of the commonly used DTP software is Quark Express.

Spreadsheet: Imagine the days of calculating budgets, involving voluminous numbers checking either manually or by using calculators. In electronic spreadsheets, a series of rows and columns are displayed. One can view just a part of it and scroll the sheet as per requirement. The text, numbers or formulas can be put into cells to create a worksheet. Even logical computations are possible by using spreadsheets. Spreadsheets are also used to generate charts and graphs to establish a relationship among the data or to make an analysis of the data entered. One of the main advantages of this electronic spreadsheet is editing i.e. all the invalid data or the wrongly entered data can be modified. They are generally used in accounts section of an organization to take out the ledgers, in institutes to take out the results of the students or in the departments where statistical computation is done, etc. One can have a number of sheets in one file, and these can also be inter-linked. Spreadsheets nowadays are generally three-dimensional.

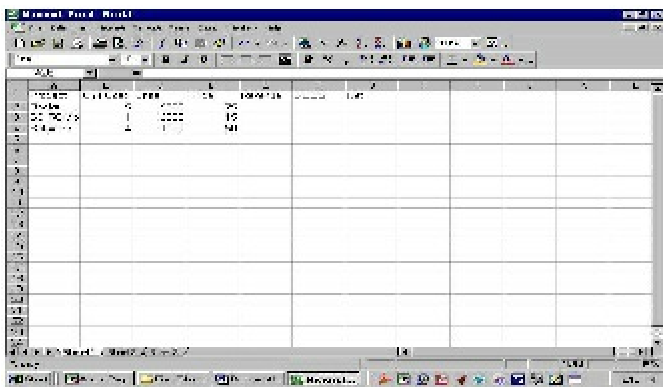


Figure 1.5: Automating Calculations using Microsoft Excel

Database Management Systems (DBMS): Database Management System provides you with the ability to have well-organized collections of data (database) and to retrieve them in the order required. Tools are provided in DBMS to use the data in subsets, and relationships can be established to accomplish the required activity. For example, in an institution, the records can be sorted out either on the basis of the names or roll numbers or ages of the students, and you can refer to the sorted files for any information. Retrieving information has become child's play by using DBMS, that is data can be sorted out on a number of fields or can be categorized, and they can even be combined together to get some typical information. For example, you want to know the address of a student but you do not know his full name. You just have an idea that his last name is "Sahni" and his age is between 14 and 16. Then DBMS can help you out by displaying the list of students whose surnames are "Sahni" and age is between 14 and 16. Only those records will be selected and displayed which meet the specified conditions. The commonly used DBMS are FoxPro 6.0, Microsoft Access, Oracle 8I, SQL Server etc.

Figure 1.6: Watching Movie from a Site on World Wide Web

Communications: The software programs that are used to work in combination with some other devices are called communication software. We use a number of communication software like fax, Internet, network etc.

- Fax Software: The computer can work as a fax machine. A fax can be sent by and received on a computer like any other fax machine. Many online service providers like America Online (AOL), Microsoft Network etc, distribute this type of software. This software is freely available on the Internet and can be downloaded. Only a computer and a telephone line are required.
- Network Software: Another type of communication software is network software, that allows users to create a network which is simply a number of computers connected together in one room, a building, a city, a country or the whole world. To connect the computers on a small scale one just needs computer, cables and software like Win NT, Unix, Linux or Novell's NetWare. To connect to the whole world together by computer, i.e. to get connected to anywhere in the world with one PC, one needs just a modem and a telephone line, where the modem is used to translate the signals of the computer, and the telephone lines act as carriers of the data from one place to another. This multi-user transport system enables one to send emails, to chat with people sitting miles away, to talk to them with the help of a microphone and a speaker attached to the system, to make online bookings for airlines, hotels or even movies. This is very helpful in accessing the computer resources which are located elsewhere. You can even get your groceries delivered to your doorstep. This has made life very easy and convenient, as one can access almost anything one can think

of, just sitting at home.

Graphics, Multimedia and Presentation Application: The programs needed to play with images are known as graphics software. They can be used for tasks ranging from making simple drawings, to making animated movies that leave a great impact on audiences. Sometimes the viewers do not even come to know that it was a mirage created by the computer.

Figure 1.7

Using paintbrush software, simple painting or drawing can be done. Images can be edited with the help of software like imaging, whereas for bigger graphical software that includes multimedia, multimedia-authoring software is used. They include images, text, sounds, animation and videos etc. They help in combining all the above and blending them wonderfully. This software includes special tools for synchronizing the sounds with moving pictures, text and images. They are very commonly used to make computer animations, audio and video albums etc. The video games, which kids play with great interest, are all made with the help of these multimedia softwares.

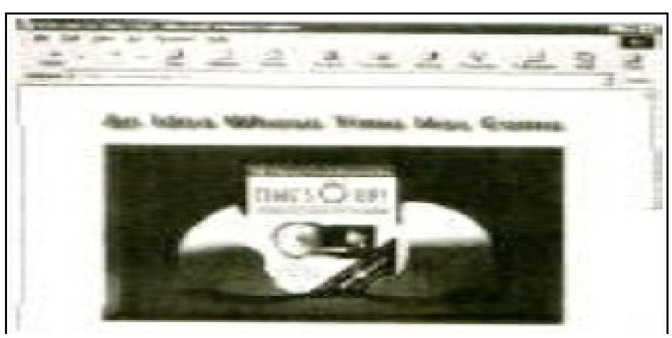


Figure 1.8

CAD software is also a kind of graphics software, which is generally used by architects and engineers to design buildings or products before they are actually built or manufactured.

Presentation graphics is another type of graphics software, which is very useful in preparing beautiful and attractive presentations that are easily understood by the audience. It include transparencies, computer presentations, etc., which can be displayed by using projectors. Handouts can also be designed by these presentation packages. Slides have a combination of text, image, clipart, sound and visual effects. Automatic slide show can also be set meaning the speaker doesn't have to divert his attention on changing the slides but concentrate only on the speaking or the explanation of the contents of presentation. Animated slide shows with sound effects can also be designed to give a more professional look. Graphs and charts can also be imported from spreadsheets and included in the presentation software to give the audience a better understanding of the matter. A commonly used presentation software is Microsoft Power Point.

Education and Entertainment Software

From a child of three to a professor of 50 computer programs are used for the purpose of education. Children not only use them for their games but also for educational programs like encyclopedias, mathematical drawing and other subjects. In schools and colleges, students prepare their presentations and even make their notes on computers. In graduate schools, all assignments are submitted on the computer itself.

Educational programs teach kids how to perform simple calculations, how to make words from alphabets, how to pronounce them etc. Children learn them in a fun atmosphere. They enjoy it and the purpose of giving them training is also solved. It is easy for students in higher classes or profession to learn through audio and video aids. Doctors can see and perform electronic surgeries for practice whereas an engineer can design products and can also find out the most suitable output before actually producing or manufacturing it. Astronomers can use them for finding out the correct position of stars and planets and the dates of eclipses etc., whereas crime branches in the police can teach the cadets the method of matching the fingerprints or even the faces of the criminals. Thus you can learn so many things while playing, as it is more interesting.

Utilities

This is the software, which generally comes with the operating system but is also available otherwise. The software provides tools for assisting the computer operations utilities including helping you out by taking up the backup of the data that has accidentally been erased, or by arranging the data and information required by the user. Nowadays most of the utilities come as a part of the operating system. Windows operating systems come with many tools that take care of your disks, anti-viruses, back up etc. Utilities help in solving the problems that keep creeping up every now and then, thus enabling your computer to function smoothly.

Resource Discovery Software

The latest and the most prevailing innovation in the area of IT is the widely spread Internet. It is like a sea—the more you explore the more is there to know. The Internet is nothing but a global network of linked computer networks with the help of telephone links and satellites. To access the vast sea of knowledge on these networked computers some commonly and popularly used tools are Archie, Gopher and the World Wide Web which help the user in accessing the computer resources available to the people who are globally connected.

PEOPLE

Although it sounds odd, it is, however, a fact that people are a part of the computing process. By people we do not mean the direct involvement of people. The people are sometimes indirectly involved in the computing process. Even the fully automated computerized machines, which operate without human intervention (discussed earlier), are designed and manufactured by people, and even their maintenance is not possible without human intervention at times. Thus, the computer ultimately works under the human being and can never be the boss!

People involved in the computing process can broadly be classified into users (or end users), power users, and computer professionals.

People who operate the computers are called users or end user, whereas power users are the people who work on specified tasks. Knowledge of power users is more than that of the basic users and they (power users) work on advanced features of applications programs. They customize the applications as per the requirements. They are highly knowledgeable people.

The last category is of the computer professionals. They have an in-depth knowledge about computers. They are specially trained for using the computer resources optimally. They, apart from working on the computer, take care of the performance and efficiency of computer systems. Programmers are one kind of computer professionals who create computer programs. They are the ones who do all the software-development work. Hardware engineers are also a part of computer professionals, and they look after the maintenance and hardware-related problems of the computers.

PROCEDURES

Procedures are basically the steps that a user follows to make the computer work, and these also include the steps the computer follows to accomplish the instructions given by the user.

Take an example of using an ATM card. You go to the bank, insert your card, some instructions are displayed on the screen (like enter your PIN number), and you keep following the instructions which the computer gives to you. Finally, you achieve what you wanted to, like getting fast cash or depositing a cheque. You take back the card and go away. Another example could be setting a phone alarm or registering the complaint of your phone. You follow the instructions you are told to, like enter your faulty telephone number etc. These are examples of computer procedures. You will come across numerous such kinds of computer processes in your daily life.

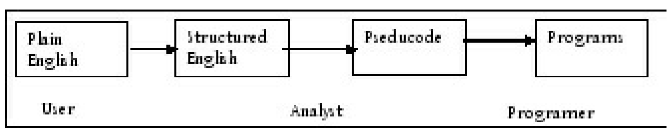
STRUCTURED ENGLISH

The purpose of a Structured English business process definition language is to describe a process in unambiguous terms that can be easily read and understood by a non-technical business user.

You can develop your own structured English style that suits your company. Some good style points to follow are:

- Express all logic in terms of sequential structures, decision structures, or iterations
- Use uppercase for keywords like IF, THEN, ELSE DO, WHILE, and lower case for everything else. This ensures that the logical structure of the process is easily visible
- Use indentation to reinforce the logical structure of the process
- Keep the description high-level

The flow of structured English can be represented by the following Figure:



The main difference between Structured English and Program is that syntax rule are not very strict and an English statement is used to specify an action. The main aim is to allow easy readability, which helps in documentation. The following conventions are used in writing structured English

1. Imperative Sentences: This consists of an imperative verb followed by the action to be performed on variables. For example:

   Store profit in revenue

   Subtract new price from old price

   are some examples of imperative sentences

2. Arithmetic and Relational Operations: Common symbols used in arithmetic are also used in Structured English. They are:

   + for Add; - for Subtract; * for Multiply; / for Divide

   Symbols used in relational operations are:

   = equal to; > greater than; < less than; != not equal to; <= less than equal to; >= greater than equal to

Symbols used for logical operations are:

and, or, not

Symbols used as keywords are:

if, then, else, repeat, until, while, do, case, end ,for etc.

3. Decision Structure: There are two types of decision structure used in Structured English statement. One of them is **if then else** structure, where a condition is checked and the decision is given on the basis of the truth or falsity of the outcome.

```
IF condition1 THEN
        block of steps1
 (ELSE IF condition THEN
        block of steps n)
         [ELSE
                block of steps otherwise]
END IF
```

The other structure is case structure where the condition being checked results in more than one output. Hence a number of cases arise as the result of condition checking, which are dealt with individually.

```
SELECT expression
CASE range of values 1
        block of steps1
(CASE range of values n
        block of steps n)
(ELSE
        block of steps otherwise]
END SELECT
```

4. Repetition: This is one of the most powerful structures used in the computer programming. This structure based on a condition repeats itself for some stipulated iterations. There are basically two types of such structure: one in which the number of iteration is know. This is the **For** structure. If there are fixed iterations to be done, for example, to add the marks of a student in five subjects, the loop will be repeated five times, then this structure is used. The other type of repletion statement is when

the exiting from the loop depends on the condition to be true or false. In the **Do-Repeat** or the **Do-While** structure conditional statement the loop is terminated when the condition is false. The structure exits the loop when the condition becomes true.

In the **While-Do** kind of structure the loop is iterated till the condition is true. For example if we have to print all the records in a file till the end of the file, we state the condition as:

```
while (not end of file)
        print record
        move to next record
do
```

In the above the code will run till the file reaches its end.

There are various forms in which we can implement Structure English to solve our problem. They are Algorithm, Flowchart and Pseudocode. We will deal with each one in the following section.

INTRODUCTION TO ALGORITHMS

Algorithms were used to solve everyday problems long before computers were even invented. The word algorithm comes from the name of the 9th century Persian mathematician Abu Abdullah Muhammad bin Musa al-Khwarizmi. The word algorism originally referred only to the rules of performing arithmetic using Arabic numerals but evolved into algorithm by the 18th century. The word has now evolved to include all definite procedures for solving problems or performing tasks.

The first case of an algorithm written for a computer was Ada Byron's notes on the analytical engine written in 1842, for which she is considered by many to be the world's first programmer. However, since Charles Babbage never completed his analytical engine the algorithm was never implemented on it.

Algorithms have been used for centuries to solve the most complex problems that humanity has encountered. One of the most famous algorithms was imagined in ancient Greece. Euclid's algorithm for calculating the greatest common divisor of two integers had and still does have impacts on the mathematical world. The importance of algorithms in today's society should not be underestimated. The computer, for example, would otherwise be useless since almost all programs are written using an algorithmic approach.

Algorithm can be formally defined as:

"A formula or set of steps for solving a particular problem. To be an algorithm, a set of rules must be unambiguous and have a clear stopping point. Algorithms can be expressed in any language, from natural languages like English or French to programming languages like FORTRAN."

We use algorithms every day. For example, a recipe for baking a cake is an algorithm. Most programs, with the exception of some artificial intelligence applications, consist of

algorithms. Inventing elegant algorithms -- algorithms that are simple and require the fewest steps possible -- is one of the principal challenges in programming.

Properties of an Algorithm

1. Correctness - is a characteristic that is most necessary. An algorithm should be implementable on a computer and give a correct answer to a given problem (in a finite amount of time).
2. Efficiency - A good algorithm should make efficient use of the two main resources in a computer system, time and space. A good algorithm should make efficient use of time and space not only in the theoretical sense but also in its actual running time for the cases of interest to the user of the algorithm.
3. Ease - A good algorithm should be easy to implement (in terms of the number of times it will be run).

In the above properties first is of course, the most essential. An algorithm must be implementable and correctly give the desired output. The rest of the properties are relative. An algorithm may use extra space (or memory) but give faster results. It may be that the algorithm will be used thousands of times once it is implemented, so we can choose a more efficient algorithm which is not so easy to implement. It may be that an algorithm makes efficient use of time and space in theory but is inefficient in practice or for the sizes of input we will be encountering.

Here is a simple example of an algorithm.

Imagine you have an unsorted list of random numbers. Our goal is to find the highest number in this list. Upon first thinking about the solution, you will realize that you must look at every number in the list. Upon further thinking, you will realize that you need to look at each number only once. Taking this into account, here is a simple algorithm to accomplish this:

1. When you begin, the first number is the largest number in the list you've seen so far.
2. Look at the next number, and compare it with the largest number you've seen so far.
3. If this next number is larger, then make that the new largest number you've seen so far.
4. Repeat steps 2 and 3 until you have gone through the whole list.

FLOWCHART

A flowchart (also spelled flow-chart and flow chart) is a schematic representation of a process. It is commonly used in business/economic presentations to help the audience visualize the content better, or to find flaws in the process. A flowchart illustrates the steps in a process. By visualizing the process, a flowchart can quickly help identify bottlenecks or inefficiencies where the process can be streamlined or improved. It allows one to break any process into individual events or activities, and to display these in shorthand form, showing the logical relationships between them.

Examples include instructions for a bicycle's assembly, an attorney outlining a case's timeline, the diagram of an automobile plant's work flow, the decisions to be taken on a tax form, etc.

How to Draw a Flowchart?

A basic flowchart identifies the starting and ending points of a process, the sequence of actions in the process, and the decision or branching points along the way. Generally the start point end points, inputs, outputs, possible paths and the decisions that lead to these possible paths are included. Flow-charts can be created by hand or manually in most office software, but lately specialized diagram drawing software has emerged that can also be used for the purpose, such as Visio, Openoffice.org Draw and Dia.

Four particular types of flow charts have proven useful when dealing with a process analysis: top-down flow chart, detailed flow chart, work flow diagrams, and deployment chart. Each of the different types of flowcharts tends to provide a different aspect to a process or a task. Flow charts provide an excellent form of documentation for a process, and are quite often useful when examining how various steps in a process work together.

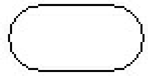
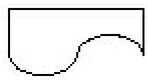
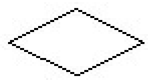
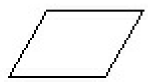
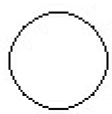
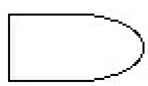
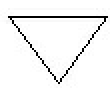
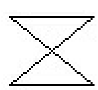
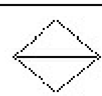
When dealing with a process flowchart, two separate stages of the process should be considered - the finished product or how to operate the process and the making of the product.

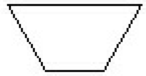
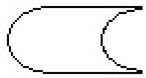
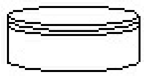
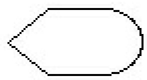
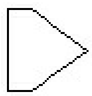
Step-by-Step process of how to develop a flow chart:

- Gather information on how the process flows: use conservation, experience, or product development codes
- Trial process flow
- Allow other more familiar personnel to check for accuracy
- Make changes if necessary
- Compare final actual flow with best possible flow.

Flowchart Symbols

Flowcharts use special shapes to represent different types of actions or steps in a process. Lines and arrows show the sequence of the steps, and the relationships among them. All the symbols are illustrated in the following Figure.

	**Start/End:** The terminator symbol marks the starting or ending point of the system. It usually contains the word "Start" or "End."
	**Action or Process:** A box can represent a single step ("add two cups of flour"), or and entire sub-process ("make bread") within a larger process.
	**Document:** A printed document or report.
	**Decision:** A decision or branching point. Lines representing different decisions emerge from different points of the diamond.
	**Input/Output:** Represents material or information entering or leaving the system, such as customer order (input) or a product (output).
	**Connector:** Indicates that the flow continues where a matching symbol (containing the same letter) has been placed.
	**Flow Line:** Lines indicate the sequence of steps and the direction of flow.
	**Delay:** Indicates a delay in the process.
	**Merge:** Indicates a step where two or more sub-lists or sub-processes become one.
	**Collate:** Indicates a step that orders information into a standard format.
	**Sort:** Indicates a step that organizes a list of items into a sequence or sets based on some pre-determined criteria.
	**Subroutine:** Indicates a sequence of actions that perform a specific task embedded within a larger process. This sequence of actions could be described in more detail on a separate flowchart.

	**Manual Loop:** Indicates a sequence of commands that will continue to repeat until stopped manually.
	**Loop Limit:** Indicates the point at which a loop should stop.
	**Data storage:** Indicates a step where data gets stored.
	**Database:** Indicates a list of information with a standard structure that allows for searching and sorting.
	**Display:** Indicates a step that displays information.
	**Off Page:** Indicates that the process continues off page.

There are five rules that should be considered while drawing a flowchart:

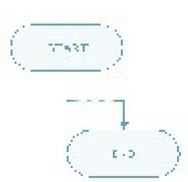
Rule 1: Program flowchart should use conventional symbols. This helps to keep uniformity and understandability.

Rule 2: The logic of a program flowchart should flow from top to bottom and from left to right. This allows Standard English convention and imposes consistency upto the drawing.

Rule 3: Each symbol used in a program flowchart should have at most one entry point and one exit point. This will always lead to same solution and consistency.

Rule 4: As far as possible, the instruction within the symbols of a program flowchart should be independent of any particular programming language. It is not always known in which programming language the actual code would be written. So the instruction should be written in simple English language.

Rule 5: All decision branches should be labeled. The decision box gives two output: one is a true and the other is a false, or a yes and a no. Both branches should be correctly labeled according to the decision being made.

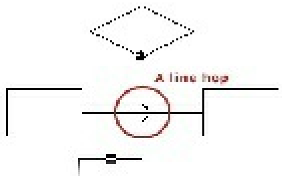


Tips for Effective Flowcharts

1. Label each flowchart with a title identifying the process that it illustrates. (For example: "Order Entry Process").
2. Clearly indicate the starting and ending points of the process, using the standard

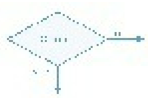
terminator symbols.

3. Keep the direction of flow consistent. Avoid confusion by keeping your flow lines moving from top to bottom and left to right. Don't reverse the direction in the chart unless the flow reverses itself in reality.



4. Break the steps down to a consistent level of detail. Don't include trivial sub-steps of one task while treating another equivalent task as a whole. If one step or task needs to be analyzed in detail, make a separate chart illustrating that sub-process.

5. Avoid crossing flow lines. In a well-designed chart, flow lines will not cross each other. By rearranging a chart you can usually get rid of crossed lines. If two lines must cross, use a "bridge" (also known as a "line hop") to show that the lines do not intersect.



6. Make sure there are at least two outcomes from every decision diamond.

7. Label your flowchart components. Use active verbs to label activity steps and questions to label decisions. Clearly label the outcomes from a decision diamond in terms that answer the question.

Advantages of Using Flowcharts

The benefits of flowcharts are as follows:

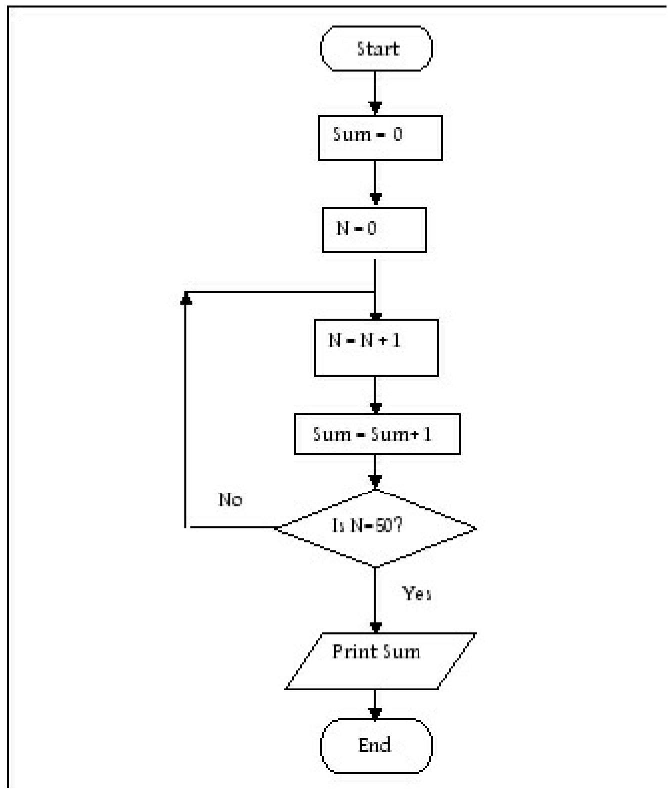
1. Communication: Flowcharts are a better way of communicating the logic of a system to all concerned.
2. Effective Analysis: With the help of a flowchart, a problem can be analyzed in a more effective way.
3. Proper Documentation: Program flowcharts serve as good program documentation, which is needed for various purposes.
4. Efficient Coding: The flowchart acts as a guide or blueprint during the systems analysis and program development phase.
5. Proper Debugging: The flowchart helps in the debugging process.
6. Efficient Program Maintenance: The maintenance of an operating program becomes easy with the help of a flowchart. It helps the programmer to put efforts more efficiently towards that part.

Limitations of Using Flowcharts

1. Complex Logic: Sometimes the program logic is quite complicated. In such a case, the flowchart becomes complex and clumsy.
2. Alterations and Modifications: If alterations are required the flowchart may need to be re-drawn completely.
3. Reproduction: As the flowchart symbols cannot be typed, reproduction of a flowchart becomes a problem.
4. The essentials of what is done can easily be lost in the technical details of how it is done.

Let us now see some examples of flowcharts.

Example 1: To draw a flowchart to find the sum of first 50 natural numbers.



Sum of first 50 natural numbers

PSEUDOCODE

Pseudocode is a kind of structured English for describing algorithms. It allows the designer to focus on the logic of the algorithm without being distracted by details of language syntax. At the same time, the Pseudocode needs to be complete. It describes the entire logic of the algorithm so that implementation becomes a rote mechanical task of translating line by line into source code.

In general the vocabulary used in the Pseudocode should be the vocabulary of the problem domain, not of the implementation domain. The Pseudocode is a narrative for someone who knows the requirements (problem domain) and is trying to learn how the solution is organized.

Each textbook and each individual designer may have their own personal style of Pseudocode. Pseudocode is not a rigorous notation, since it is read by other people, not the computer. There is no universal "standard" for the industry, but for instructional purposes it is helpful if we all follow a similar style. The format below is recommended for expressing your solutions in our class.

Pseudocode uses the pattern of structured English. The basic constructs for flow of control are as follows:

- SEQUENCE is a linear progression where one task is performed sequentially after another.
- WHILE is a loop (repetition) with a simple conditional test at its beginning.
- IF-THEN-ELSE is a decision (selection) in which a choice is made between two alternative courses of action.
- REPEAT-UNTIL is a loop with a simple conditional test at the bottom.
- CASE is a multiway branch (decision) based on the value of an expression. CASE is a generalization of IF-THEN-ELSE.
- FOR is a "counting" loop.
- SEQUENCE

Here is an example to illustrate these constructs.

```
READ height of rectangle
READ width of rectangle
COMPUTE area as height times width
```

Here the common Action Keywords are as follows.

Input: READ, OBTAIN, GET

Output: PRINT, DISPLAY, SHOW

Compute: COMPUTE, CALCULATE, DETERMINE

Initialize: SET, INIT

Add one: INCREMENT, BUMP

- IF-THEN-ELSE

The general form of this structure is

```
IF condition THEN
        sequence 1
ELSE
        sequence 2
ENDIF
```

The ELSE keyword and "sequence 2" are optional. If the condition is true then sequence 1 is performed, otherwise sequence 2 is performed. For example

```
IF HoursWorked > NormalMax THEN
        Display overtime message
ELSE
        Display regular time message
ENDIF
```

- WHILE

The general form of this structure is

```
WHILE condition 1
        sequence 1
ENDWHILE
```

The loop is entered only if the “condition 1” is true. The "sequence 1" is performed on every iteration. At the conclusion of each iteration, the condition is evaluated and the loop continues as long as the condition is true. For example

```
WHILE Population < Limit
        Compute Population as Population + Births - Deaths
```

ENDWHILE

- CASE

There are four keywords, CASE, OF, OTHERS, and ENDCASE, and conditions that are used to indicate the various alternatives. The general form is:

```
CASE expression OF
        condition 1 : sequence 1
        condition 2 : sequence 2
        ...
        condition n : sequence n
        OTHERS:
        default sequence
ENDCASE
```

The OTHERS clause with its default sequence is optional. Conditions are normally numbers or characters indicating the value of "expression", but they can be English statements or some other notation that specifies the condition under which the given sequence is to be performed. A certain sequence may be associated with more than one condition.

Example

```
CASE Title OF
        Mr.       : Print "Mister"
        Mrs.      : Print "Missus"
        Miss.     : Print "Miss"
        Ms.       : Print "Mizz"
        Dr.       : Print "Doctor"
ENDCASE
```

Example

```
CASE grade OF
        A       : points = 4
        B       : points = 3
        C       : points = 2
        D       : points = 1
        F       : points = 0
```

ENDCASE

- REPEAT-UNTIL

Two keywords, REPEAT and UNTIL are used. The general form is:

REPEAT

sequence 1

UNTIL condition 1

The "sequence 1" in this type of loop is always performed at least once, because the test is performed after the sequence is executed. At the conclusion of each iteration, the “condition 1” is evaluated, and the loop repeats if the “condition 1” is false. The loop terminates when the “condition 1” becomes true.

- FOR

This loop is a specialized construct for iterating a specific number of times, often called a "counting" loop. Two keywords, FOR and ENDFOR are used. The general form is:

FOR iteration bounds

sequence

ENDFOR

In cases where the loop constraints can be obviously inferred it is best to describe the loop using problem domain vocabulary. For example

FOR each month of the year (good)

FOR month = 1 to 12 (ok)

FOR each employee in the list (good)

FOR empno = 1 to listsize (ok)

- NESTED CONSTRUCTS

The constructs can be embedded within each other, and this is made clear by use of indenting. Nested constructs should be clearly indented from their surrounding constructs. For example

SET total to zero

REPEAT

READ Temperature

IF Temperature > Freezing THEN

```
    INCREMENT total
  END IF
  UNTIL Temperature < zero
  Print total
```

In the above example, the IF construct is nested within the REPEAT construct, and therefore is indented.

REVISION EXERCISES

Fill in the blanks

1. Portable computers that fit into a briefcase are called _________ .
2. _________ refer to the combination of hardware, software, data, people and procedures.
3. Electronic instructions that tell a computer what to do are called _________.
4. A _________ is a group of electronic devices used for processing data.
5. A keyboard and a screen wired to a mainframe together are known as a ________.
6. A program is a list of _________ guiding a computer on what to do.
7. A binary digit, called _________ has a value _________ or _________
8. The machine and its components are called _________.
9. The irrational fear of computers is termed as _________.
10. Application programs that can be used to do many related tasks are called _________.
11. A group of programs designed to work together to perform a task is called a software _________.
12. _________ was the first Computer programer.
13. High-Level-language was introduced during the _________ computer generation.
14. A program flowchart indicates the_________ to be per formed and the __________ in which they occur.
15. A program flowchart is generally read from _______________________ to ________________
16. Flowcharting symbols are connected together by means of ___________________
17. A decision symbol may be used in determining the ________________ or ___________ of two data items.
18. __________ are used to join remote portions of a flowchart
19. ____________ connectors are used when a flowchart ends on one page and begins again on other page

20. A ________ symbol in used at the beginning and the end of a flowchart.

21. The flowchart is one of the best ways of ________ a program..

22. To construct a flowchart, one must adhere to prescribed symbols provided by the __________ .

23. The programmer uses a ____________ to aid him in drawing flowchart symbols.

Answers

1.	Laptop	2.	Computer systems	3.	Programs
4.	Computer	5.	Workstation		
6.	Instructions	7.	Bit, zero, one		
8.	Hardware	9.	Cyberphobia		
10.	General purpose software	11.	Package		
12.	Augusta Ada Byron	13.	Second		
14.	Operations, sequence	15.	Top, down		
16.	Flow line				
17.	Equality, inequality	18.	Connectors		
19.	Off -page	20.	Terminal		
21.	Documenting				
22.	ANSI (American National Standards Institute)				
23.	Flowcharting template				

Tick-mark the correct answer

1. What is the name of the cycle that describes the computer's processing of data:

   A. Processing cycle

   B. Cyber-phobia cycle

   C. IPOS Cycle

   D. Information cycle.

2. What are the two essential parts of the computer?

   A. Keyboard and mouse

   B. Hardware and software.

   C. Printer and screen

D. None of the above

3. The purpose of the computer is to process the data into

A. Meaningful data

B. Information

C. Arithmetic operations

D. Formulas

4. How are software packages categorized?

A. Hardware and software

B. Word processing and spreadsheets

C. System software and application software

D. None of the above

5. The software can be divided into:

A. System software and application software

B. General purpose software and special purpose software

C. Operating system and application software

D. None of the above

6. The software required to run the computer is .....

A. Application software

B. Microsoft word

C. Programs

D. Operating system

7. What is the other name for the personal computers:

A. Mainframes

B. Super computers

C. Desktop computers

D. Microcomputers

Answers

1.	(C)	2.	(B)	3.	(B)	4.	(D)
5.	(A)	6.	(D)	7.	(D)		

REVIEW QUESTIONS

1. Describe the IPOS cycle.
2. Name five everyday places where you encounter the computer, and describe how it is used at respective places.
3. Explain three types of software that can be used to publish a newsletter or a book. Write in detail how three of them can be useful.
4. What is the difference between memory and storage? Why do we require both to function properly?
5. What is the difference between data and information? Why are both of them important individually?
6. Describe the five types of computers. Write their differences in characteristics also.
7. What is the difference among users, power users and professionals?
8. Write down the configuration of a computer, you would like to buy for your personal purpose.
9. Write the five elements of the computing process.
10. Write the characteristics of useful and meaningful information.
11. Write the pros and cons of using a computer.
12. Vacuum tube based electronic computers belong to
    a. First Generation
    b. Second Generation
    c. Third Generation
13. The _______ generation of computers was characterized by microcomputers.
    a. First
    b. Second
    c. Third
    d. Fourth
14. The second generation of computers was characterized by _____.
    a. magnetic cards
    b. artificial intelligence

c. transistors

d. transformers

15. Integrated circuits signified the beginning of the ______ generation of computers.

a. First

b. Second

c. Third

d. Fourth

16. The acronym ENIAC stands for ______.

a. Electrical Neon Infuser And Calculator

b. Electronic Numerical Integrator and Computer

c. Eulogistic Nuisance In A Cart

d. Electronic Number Interpreter And Calculator

17. The first counting tool was the __________.

a. Abacus

b. Slide Rule

c. ENIAC

18. __________ is known as the first woman programmer.

a. Charles Babbage

b. Lady Lovelace

c. Abacus

19. The difference between a calculator and a computer is that a computer can store data for long periods of time.

a. True

b. False

20. Computers use base two number system because

a. it is easier to do calculations than in a base 10 system

b. they are made of switches, which are either on or off

c. it was the first number system used by people

d. the first mechanical calculators used the same number system

Answers

12.	(a)	13.	(d)	14.	(c)
15.	(c)	16.	(b)	17.	(a)
18.	(b)	19.	(b)	20.	(b)

Chapter 2: DATA REPRESENTATION

INTRODUCTION

Even people who have been using computers for a few years still marvel at what they can do - how at lightning speed and with amazing accuracy they can sort a mailing list, balance a ledger, typeset a book, or create lifelike models of objects that have never existed.

Just how a computer does all this may seem magical, but in fact it is a process based on simple concepts. All the words, numbers and images you put into and get out of the computer are manipulated in relatively simple ways by the computers' processing components.

In this chapter you will learn what data is, how it differs from information, and what form it takes inside the computer.

DATA AND INFORMATION

Data

We generally talk about data and information. Are they the same terms? And if not, what is the difference between them? Well, data is the raw material and information is what we get after processing the data. To be more precise, data is raw facts and figures and information is processed data, that is useful and meaningful. Data is the input to processing, and information is the output.

How is data converted into information is explained in the Figure:

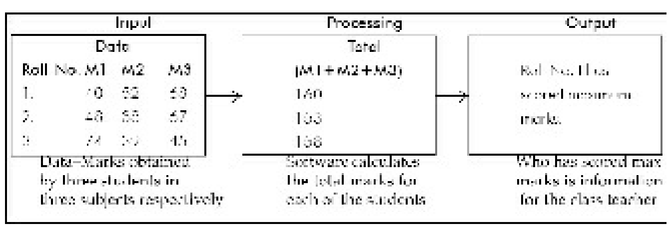


Figure 2.1

Data is a plural form. The singular form of data is "datum" which is rarely used.

Information distinguishes itself from data, as it is more useful and meaningful. The marks of the subjects, as such are of no use for the teacher but then calculating the total helps him in finding out the ranks of the students. One information can be used as the data for taking out another information, i.e. one information becomes input for another type of output, e.g. the total marks calculated as shown above will serve as data to find out the percentage and hence the division of the students, to check how many students have scored distinction, first class, second class or failed. Information can be distinguished from data by some characteristics like whether it is relevant, timely, and accurate, concise and complete. Data should be accurate but may not necessarily possess rest of the characteristics. The characteristics of information are explained as:

- Relevant: The information should apply to the situation or the query or problem.
- Timely: Information should be presented as and when required. For example, there is no point receiving newspaper after two-three days.
- Accurate: Input and output should be accurate, so that no wrong decisions take place. A small mistake can lead to hazardous results.
- Reliable: It should be reliable, i.e. there should not be any doubt about the presented information.
- Concise: It should not be unnecessarily lengthy, i.e. precision is an important characteristic of information.
- Complete: All the important elements should be covered and nothing should be missed.

It seems that computers understand us as we understand them. However, this is not true. They do not understand the language we normally use among ourselves. It is their own language which they understand. That language comprises of two distinct physical states produced by electricity, magnetic polarity, or reflected light. All they can understand is whether a switch is on or off. In fact the “brain” of the computer, the CPU, consists primarily of several million of tiny electronic switches, called transistors.

A computer only appears to understand information because it contains so many transistors and operates at such phenomenal speeds, assembling its individual on/off switches into patterns that are meaningful to us.

The term used to describe the information represented by groups of on/off switches is data. Although the words data and information are often used interchangeably, there is an important distinction between them. Data is raw facts that the computer organizes to produce information.

Data can be explained more explicitly by taking an example. The letters G, O and D do not indicate anything individually but when combined together they do give you a word GOD, which has some meaning. Similarly, a few words can be combined together to form a sentence that might convey some meaningful message to you and thus become information to you. The computer converts the data into information by processing it in some way.

REPRESENTATION OF CHARACTERS IN COMPUTERS

To discuss how a computer processes data, we should first have an understanding of the form in which data is stored in the computer's memory. There are two basic types of data which are stored and processed by a computer. They are characters and numbers. But to a computer everything is number. Numbers are numbers, letters are numbers, punctuation marks are numbers, sounds and pictures are numbers, even the computer's own instructions are numbers. This might seem very strange.

Characters and numbers are assigned different values by the computer. The output from a computer must be in the form that is understood by the users. Thus the computer translates those values into the form understandable by the normal users, which is again natural language consisting of numbers and characters. This constitutes EXTERNAL DATA REPRESENTATION. On the other hand, the values used by a computer to store and process the data is INTERNAL REPRESENTATION OF DATA.

Let us see how external data representation is different from the internal data representation. For example, consider the following sentence: GOD IS EVERYWHERE.

It may look like a sentence or a string of characters to you but for the computer it is a string of numbers (just zeros and ones). The computer interprets the sentence in the manner discussed below.

Internal data representation in a computer looks strange because people are in the habit of using base 10 to represent numbers. The system is called base 10 or the DECIMAL SYSTEM (deci means 10 in Latin). This system uses 10 symbols, viz., 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0. When you need to represent a number greater than 9, you use two digits instead of one, as 9+1=10 and so on. Each symbol in a number is called a digit and, therefore, we can say that the number 10 is a two-digit number.

In the computer all the data has to be converted into electrical switches. A switch has only two states: "on" and "off". And as they take only two numeric symbols they are said to function in base 2. This number system is known as BINARY SYSTEM (BI means two).

When a computer needs to represent a quantity greater than 1, it does the same thing you do when you need to represent a quantity greater than 9 in decimal. It uses two or more binary digits.

BITS AND BYTES

When referring to computerized data, each switch whether it is on or off is called a bit. The term bit is nothing but the contracted form of Binary Digit. A bit is the smallest possible unit of data. To represent anything meaningful – in the other words, to convey information – the computer needs groups of bits.

After the bit, the next larger unit is byte. The byte is a group of 8 bits. With one byte, the computer can represent up to 256 different values because it is possible to count from 0 to 255 with these 8 binary digits.

The byte is a very important unit because there are enough different eight-bit combinations to represent all the characters on the keyboard including all the letters (uppercases and lowercases, punctuation marks, numbers and other symbols). The byte is basic unit for measuring the size of memory; although with today's memory sizes, it is more common to hear terms like kilobyte (KB) or megabyte (MB) or gigabyte (GB).

1 Kilobyte (KB)	=	1024 bytes ~ 1000 bytes
1 Megabyte (MB)	=	1024 kilobytes ~1000 KB
1 Gigabyte (GB)	=	1024 megabyte ~ 1000MB

The number of adjacent bits that can be stored and manipulated as a unit is called a computer word. Some of the newer microcomputers have the ability to manipulate a 32-bit word, whereas the older ones could process words up to 16 bits. The length of the word matters, as the longer the word (that registers can hold), the more would be the processing speed.

TEXT CODES

Characters are similarly represented as series of binary 1's and 0's. However, there must be some universally accepted standard coding scheme to do this coding. This way, all the values representing digits, characters, punctuation marks and special symbols can be coded uniquely in terms of binary digits. The three most popular systems developed for this purpose are EBCDIC, ASCII and Unicode.

EBCDIC

Binary Coded Decimal (BCD) system was designed by IBM for one of its early computers. It was one of the first complete systems to represent symbols with bits. BCD codes consisted of 6-bit codes, which allowed a maximum of 64 possible symbols. BCD computers could work only on uppercase letters and a very few other symbols. That was the reason of their not being in use for a long time.

The need for more symbols led IBM to develop EBCDIC system. EBCDIC is pronounced as "EB-SI-DIC" and stands for Extended Binary Coded Decimal Interchange Code. EBCDIC is an 8-bit code that defines 256 symbols. EBCDIC is still used in IBM mainframes and mid-range systems. By the time small computers started getting developed the ANSI (American National Standards Institute) had started developing the standards for computers.

ASCII

ANSIs' defined ASCII character set used to represent the symbols, numbers, characters etc. ASCII stands for American Standard Code for Information Interchange. Today, the ASCII character set is the most common.

In this scheme of coding characters 0 to 31 are control characters, 32 to 64 are special characters, 65 to 90 are uppercase alphabets, 97 to 122 are lowercase alphabets and 123 to 127 represent some common symbols. ASCII being a 7–bit code specifies characters only up to 127. There are variations that specify different character sets for codes from 128 to 255. The ISO (International Standards Organization) offers different sets of charters for different language groups.

Unicode

A new standard for data representation, called Unicode Worldwide Character Standard, provides 2 bytes (16 bits) to represent each symbol. That means the range could be anything up to 65, 536 different characters or symbols. That means all the characters and symbols of the world can have the same standard, thus facilitating the interchanging of the data and programs written in any language without requiring any special programs.

NUMBER SYSTEM

Before we go any further we need to study the various types of number systems and also the transformation rules to inter-convert them (i.e., external representation of data into internal data and vice versa).

Representation of Integers or Decimal Numbers

We now know how characters and strings of characters are represented internally in a computer. Decimal digits are also considered as characters and codes are assigned to them. These codes for digits are primarily used when digits are used merely as symbols with no "value" assigned to them. For example DL3C 3455 is the registration number of a car, which is a combination of both numbers and characters. Now if we want to store these numbers in the computer and perform calculations too, they are required to be converted into binary system that uses only "o" and "1". The combination of zeros and ones can be used to represent the above given decimal numbers as we discussed earlier.

For example, consider the decimal number 3455. The value of each digit is determined by the digit itself (face value). The position of the digit and the base or radix of the number system determines the actual value represented.

The base of a number system is defined as the number of distinct symbols used to represent numbers in the system. The decimal system uses the ten symbols 0,1,2,3,4,5,6,7,8,9, and 0. Its base is thus 10.

To a decimal integer, we assign a value but before that we assign weights (place value) to each digit position. The weights are unity for the right most digit and changes to tens, hundreds, thousands etc. as we proceed towards the left digits of the number.

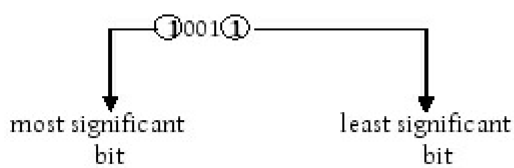
We multiply the digits of the number by its respective weights and then add them all to get the value of that number. Thus, the value of 3455 is calculated as:

3 x 1000	+ 4 x 100	+ 5 x 10	+ 5 x 1	
3000	+ 400	+ 50	+ 5	= 3455
Thousands	Hundreds	Tens	Units	
Position	Position	Position	Position	

The notation used above is called the positional system.

Binary System

As explained in the beginning of the chapter, if a number system has only two symbols then its base is 2. Such a system is called binary system. Numbers in this system are strings of bits. For example, 10011 is a binary number.



The right most bit is called LEAST SIGNIFICANT BIT and the left most bit is called the MOST SIGNIFICANT BIT. Weights assigned to the bits are the powers of 2 as 2^0= 1, 2^1= 2, 2^2= 4, 2^3= 8, 2^4= 16, etc.

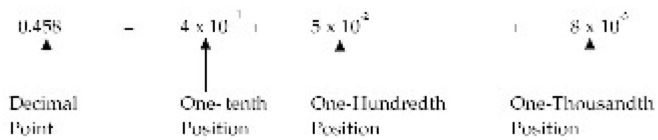
As the powers of 10 are important in the decimal system, similarly the powers of 2 play an important role when it comes to representation in the binary system. A table is given below which gives powers of 2 and their decimal equivalents. The abbreviation K stands for 1024 and is taken as 1000 (a kilo) approximately. Similarly the notations mega stands for 1024 x 1024 and so on.

Powers of 2	Decimal equivalent	Abbreviations	Powers of 2	Decimal equivalent	Abbreviations
2^0	1		2^{11}	2048	2K
2^1	2		2^{12}	4096	4K
2^2	4		2^{13}	8192	8K
2^3	8		2^{14}	16384	16K
2^4	16		2^{15}	32768‘	32K

2^5	32		2^{16}	65536	64K
2^6	64		2^{17}	131072	128K
2^7	128		2^{18}	262144	256K
2^8	256		2^{19}	524288	512K
2^9	512		2^{20}	1048576	1M
2^{10}	1024	1K	2^{21}	2097152	2M

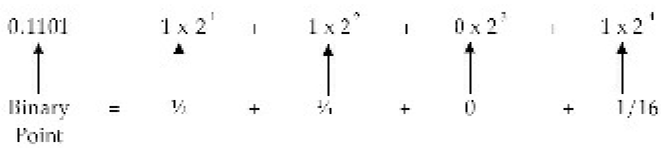
Representation of fractions (L2)

Decimal fractions are interpreted as:



Negative powers of 10 (the base) are used as the weights for the digits in the fractional part of the number.

A binary fraction is represented by a string of 1's and 0's on the right of a binary point. The bits are multiplied by negative powers of 2 to obtain the decimal value of the binary fraction as:



= 13/16

= 0.8125 (In Decimal)

Examples

1. $(110101.11)_2 = 1x2^5 + 1x2^4 + 0x2^3 + 1x2^2 + 0x2^1 + 1x2^0 + 1x2^{-1} + 1x2^{-2}$

$= 32 + 16 + 0 + 4 + 0 + 1 + ½ + ¼¼$

$= 53 + ¾$

$= 53.75_{10}$

2. $(1011.011)_2 = 1x2^3 + 0x2^2 + 1x2^1 + 1x2^0 + 0x2^{-1} + 1x2^{-2} + 1x2^{-3}$

$= 8 + 0 + 2 + 1 + 0 + 0.25 + 0.125$

$= 11.375_{10}$

Hexadecimal Representation

Counting in the binary system is similar to that in the decimal system. In decimal we start from 0, add 1, obtain 1 and continue adding 1 successively till we get 9. That means in base 10 there are symbols from 0 to 9. Now when we add 1 to 9 we get 10.1 gets carried to the tens position in the decimal system. Similarly we count 100 after reaching 99 and so on. Counting in binary proceeds exactly in the similar fashion:

0, 1, 10, 11, 100, 101, 110, 111, 1000, 1001, …

The table given below shows the binary counting sequence. Observe that we require 3 bits to represent decimal numbers 0, and 7 bits to represent 8 and 9. Thus we can say on an average there are 3.2 bits (binary digits) required to represent a decimal digit [(8 x 3 + 2 x 4)/10 =3.2]. That means, if we convert a large decimal number to obtain its binary equivalent, it would be approximately 3.2 times the number of digits of the corresponding decimal number.

Thus the binary equivalent of a ten digit decimal number would be 32 bits long. Don't you think that writing such long strings of 0s and 1s are a very cumbersome and error prone task? This problem is solved to a great extent by using the hexadecimal number system, which uses 16 as a base. There are sixteen symbols used by this system viz.: 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F. Here the symbols A, B, …, F are used to represent the numbers 10, 11 12, 13, 14 and 15 respectively. We need only 4 bits to represent a hexadecimal digit. The table below gives the hexadecimal system's symbols, their decimal and binary equivalents.

Binary number	Hexadecimal equivalent	Decimal equivalent	Binary number	Hexadecimal number	Decimal equivalent
0000	0	0	1000	8	8
0001	1	1	1001	9	9
0010	2	2	1010	A	10
0011	3	3	1011	B	11
0100	4	4	1100	C	12
0101	5	5	1101	D	13
0110	6	6	1110	E	14
0111	7	7	1111	F	15

A binary number can be quickly converted to its hexadecimal equivalent by grouping together 4 bits of the binary number, starting with the least significant digit and replacing each four bits group with its hexadecimal equivalent given in the table.

Examples

1.

Binary Number :	1101	1110	0010	1001
Hexadecimal Number :	D	E	2	9

The binary number $(1101111000101001)_2$ is converted into its hexadecimal equivalent by first making groups of four bits, starting from the least significant digit and proceeding towards the most significant digits.

2.

Binary Number :	0001	1101	1100	1001	0100
Hexadecimal Number :	1	D	C	9	4

The binary number $(00111011100.10010100)_2$ is converted into its hexadecimal equivalent by the same method as explained above but the groups are formed from left to right for the fractional part unlike in the integer part. One more thing to be noted is that, to complete a group of four bits, 0's are introduced at the left most position in the left most group in the integer part, and in the rightmost position in the right most group in the fractional part.

CONVERSIONS

All the number systems discussed above can be inter- converted to one another. The set of rules to convert them are discussed below.

Decimal to other Number Systems

Decimal numbers can be converted to other numbers by using either of the two methods given below:

Power Method

a. Write the powers of the radix till it is less than the number to be converted.

b. Subtract the highest number, which is obtained by raising the powers of the radix from the number, which is to be converted.

c. Obtain the remainder, say R.

d. Subtract the next highest number from this remainder.

e. Repeat the process till the remainder is zero.

f. Now multiply the power, which have been used with one, and multiply the powers which have not been used by zero.

Remainder Method

This is the method commonly used for the conversions from the decimal number system to the binary number system. The conversion is carried out in the following order:

divide the given number (decimal system) by the radix of the proposed system (in which the number has to be converted). Note down the remainder.

Now the quotient will again be divided by the radix and the remainder will be noted down.

The procedure goes on till zero comes as quotient.

Fraction Conversion

We have already discussed the remainder and the power methods to convert the decimal numbers to binary numbers. Now the fractional decimal numbers can be converted to binary numbers by following the steps given below:

1. Multiply the radix of the proposed system with the fraction to be converted.
2. Note down the resulting integer (if any), otherwise put down zero in that place.
3. Repeat the multiplication with the resulting fraction.
4. Keep repeating the procedure till the fraction vanishes or you encounter the recursive fractions.

Examples

1. By using the Power Method:

(i) $(220)_{10}$

Radix of the binary system = 2
Powers of radix which are less than 220

2^1	2
2^2	4
2^3	8
2^4	16
2^5	32
2^6	64
2^7	128

$$
\begin{array}{l l}
\ 220 & \\
-\ \underline{128} & \longrightarrow \quad 2^7 - 1 \times 2^7 \\
\ \ 92 & \\
-\ \underline{64} & \longrightarrow \quad 2^6 - 1 \times 2^6 \\
\ \ 28 & \\
-\ \underline{16} & \longrightarrow \quad 2^4 = 1 \times 2^4 \\
\ \ 12 & \\
-\ \ \underline{8} & \longrightarrow \quad 2^3 - 1 \times 2^3 \\
\ \ \ 4 & \\
-\ \ \underline{4} & \longrightarrow \quad 2^2 - 1 \times 2^2 \\
\ \ \ \underline{0} &
\end{array}
$$

1×2^7	1
1×2^6	1
0×2^5	0
1×2^4	1
1×2^3	1
1×2^2	1
0×2^1	0
0×2^0	0

Thus, the binary equivalent of $(220)_{10}$ is $(11011100)_2$

(ii) $(674)_{10}$

Radix of the binary system = 2

Powers of radix which are less than 674

2^1	2
2^2	4
2^3	8
2^4	16
2^5	32
2^6	64
2^7	128
2^8	256
2^9	512

$$
\begin{array}{r}
674 \\
-\ 512 \\
\hline
162 \\
-\ 128 \\
\hline
34 \\
-\ 32 \\
\hline
2 \\
-\ 2 \\
\hline
0 \\
\hline
\end{array}
$$

$2^9 = 1 \times 2^9$

$2^7 = 1 \times 2^7$

$2^5 \quad 1 \times 2^5$

$2^1 = 1 \times 2^1$

$1 \text{ x } 2^9$ 1

$0 \text{ x } 2^5$ 0

$1 \text{ x } 2^7$ 1

$0 \text{ x } 2^5$ 0

$1 \text{ x } 2^5$ 1

$0 \text{ x } 2^4$ 0

$0 \text{ x } 2^3$ 0

$0 \text{ x } 2^2$ 0

$1 \text{ x } 2^1$ 1

$0 \text{ x } 2^0$ 0

Thus, the binary equivalent of $(674)_{10}$ is $(1010100010)_2$

2. By using the Remainder Method

(i) $(220)_{10}$

2	220	
2	110	0
2	55	0
2	27	1
2	13	1
2	6	1
2	3	0
2	1	1
	0	1

While writing the binary equivalent the digits are taken from the bottom to the top (as indicated by the arrow). The binary equivalent in the above example is $(11011100)_2$

(ii) $(674)_{10}$

2	674	
2	337	0
2	168	1
2	84	0
2	42	0
2	21	0
2	10	1
2	5	0
2	2	1
2	1	0
	0	1

Thus, the binary equivalent of $(674)_{10}$ is $(1010100010)_2$

3. Fraction Conversion

(i) Converting $(0.40)_2$ to binary form

Radix = 2

	Fraction	Integer
0.40 x 2	0.80	0
0.80 x 2	= 1.60	1
0.60 x 2	= 1.20	1
0.20 x 2	= 0.40	0
0.40 x 2	= 0.80	0

thus binary equivalent of $(0.40)_{10}$ = $(0.01100...)_2$

(ii) $(12.25)_{10}$

Radix =2

Integer part = 12.

Using the remainder method:

2	12	
2	6	0
2	3	0
2	1	1
0	1	

Thus, the binary equivalent of $(12)_{10}$ is $(1100)_2$

Fraction part = $(0.25)_{10}$

	Fraction	Integer
0.25 x 2	0.50	0
0.50 x 2	= 1.00	1

The binary equivalent of $(0.25)_{10}$ is $(01)_2$

Thus, the binary equivalent of $(12.25)_{10}$ is $(1100.10)_2$

Decimal to Octal

Integer

- $(98)_{10}$

  Radix = 8

8	98	
8	12	2
8	1	4
	0	1

Thus, the octal equivalent of $(98)_{10}$ is $(142)_8$

Fraction

- $(423.03125)_{10}$

  Integer part = 423

8	423	
8	52	7
	6	4

Thus, the octal equivalent of $(423)_{10}$ is $(647)_8$

Fraction Part = 0.03125

		Fraction	Integer
0.03125 x 8	=	0.250	0
0.250 x 8	=	2.00	2

That is $(0.03125)_{10} = (0.02)_8$

Thus, the octal equivalent of $(423.03125)_{10} = (647.02)_8$

Decimal to Hexadecimal

Integer

$(8234)_{10}$

16	8234	
16	514	10 10 A
16	32	2
16	2	0
	0	2

Thus, the hexadecimal equivalent of $(8234)_{10}$ is $(202A)_{16}$

Fraction

$(0.225)_{10}$

				Fraction	*Integer*
0.225	x	16	= 3.6	0.6	3
0.6	x	16	=9.6	0.6	9

Thus, the hexadecimal equivalent of $(0.225)_{10}$ is $(0.39)_{16}$

Binary System to other Number Systems

Binary to Decimal Number System

Binary numbers can be converted to the decimal number system by multiplying each binary digit with its respective position weight and then adding all the results. Here are a few examples.

1. $(10100011)_2$

$$
\begin{array}{llcr}
1 \times & 2^7 & = & 128 \\
0 \times & 2^6 & & 0 \\
1 \times & 2^5 & = & 32 \\
0 \times & 2^4 & & 0 \\
0 \times & 2^3 & & 0 \\
0 \times & 2^2 & & 0 \\
1 \times & 2^1 & = & 2 \\
1 \times & 2^0 & & 1 \\
\hline
 & & & 163
\end{array}
$$

2. $(1101)_2$

$$\begin{array}{llcl} 1 \times & 2^{3} & = & 8 \\ 1 \times & 2^{2} & = & 4 \\ 0 \times & 2^{1} & = & 0 \\ 1 \times & 2^{0} & & 1 \\ \hline & & & 13 \end{array}$$

Binary to Decimal (Fraction)

Binary Fractions are converted to the decimal number system by multiplying each digit by its respective position weight (that is the negative powers of the base 2) and then adding them together. Here are a few examples.

$(1011.11011)_2$

Consider the integral part first

$$\begin{array}{llcl} 1 \times & 2^{3} & = & 8 \\ 0 \times & 2^{2} & = & 0 \\ 1 \times & 2^{1} & = & 2 \\ 1 \times & 2^{0} & = & 1 \\ \hline & & & 11 \end{array}$$

Consider the fraction part now:

Fraction = $(0.11011)_2$

$= 1 \text{ x } 2^{-1} + 1 \text{ x } 2^{-2} + 0 \text{ x } 2^{-3} + 1 \text{ x } 2^{-4} \text{ x } 1 \text{ x } 2^{-5}$

= ½ + 1/4¼ + 0 + 1/16 + 1/32

$= (0.84375)_{10}$

Thus, the decimal equivalent of $(1011.11011)_2$ is $(11.84375)_{10}$

Binary to Octal Number System

Binary numbers can be converted to the octal number system by two methods:

1. By converting the binary number first into the decimal number system, and then converting the number so obtained into octal number system.
2. By grouping three binary digits to produce a single octal number proceeding from the least significant bit to the most significant bit.

Here are a few examples.

1. Integer

$(110100101)_2$

First, convert the above binary number to its decimal equivalent by multiplying each digit with its respective position weight:

1	1	0	1	0	0	
1	0	1	2^8	2^7	2^6	
2^5	2^4	2^3	2^2	2^1	2^0	
256	128	0	32	0	0	
4	0	1				

$= 256 + 128 + 0 + 32 + 0 + 0 + 4 + 0 + 1$

$= 421$

Now convert this decimal to its equivalent octal form:

8	421	
8	52	5
8	6	4
	0	6

Thus, the octal equivalent of $(421)_{10}$ is $(645)_8$

$(110100101)_2 = (421)_{10} = (645)_8$

Convert the same number by the second method, that is by grouping the binary number.

Binary Number (grouped in 3 bits)	110	100	101
In equivalent exponential form	2 2 2 1 2 0	2 2 2 1 2 0	2 2 2 1 2 0
In decimal form	4 2 1	4 2 1	4 2 1
In octal from 645	4 x 1 + 2 x 1 + 1 x 0	4 x 1 + 2 x 0 + 1 x 0	4 x 1 + 1 x 0 + 1 x 1

Therefore, the octal equivalent of $(110100101)_2$ is $(645)_8$

2. Fraction

$(110111001.100001)_2$

Let us first convert the above given binary number to its decimal equivalent:

Integer part:

$(110111001)_2 = 1x\ 2^8 + 1x2^7 + 0x2^6 + 1x2^5 + 1x2^4 + 1x2^3 + 0x2^2 + 0x2^1 + 1x2^0$

$= 256 + 128 + 0 + 32 + 16 + 8 + 0 + 0 + 1$

$= (441)_{10}$

Now convert this decimal form into octal form:

8	441	
8	55	1
8	6	7
	0	6

Thus, the octal equivalent of integer part 442 is $(671)_8$

Fractional part:

$(0.100001)_2 = ½ + 1/\ 64$

$= 33/64$

$= (0.515625)_{10}$

Now convert this decimal form into octal form:

Fraction = 0.515625

	Fraction		Integer
0.515625 x 8	=	4.125	4
0.125 x 8	=	1.000	1

Thus, the octal equivalent of $(0.515625)_{10} = (0.41)_8$

Therefore, $(110111001.100001)_2 = (441.515625)_{10} = (671.41)_8$

Binary to Hexadecimal

For converting a binary number into its hexadecimal equivalent, it should first be converted into groups of four bits, and then these groups should directly be converted into their hexadecimal equivalents. The following examples illustrates the method.

$(1110100010111100)_2$

1110	1000	1011	1100
1x8+1x4+1x2+0 x 1	1x8+0x4+0x2+0x1	1x8+0x4+1x2+1x1	1x8+1x4+0x2+0x1
14=E	8=8	11=B	12=C

Thus, the hexadecimal equivalent of $(1110100010111100)_2$ is $(E8BC)_{16}$

Even the fraction part is converted into a group of four bits, and then further converted to its corresponding hexadecimal number. The grouping starts from the very next bit after the decimal, and proceeds towards the right. Here are a few examples.

$(0.11001101)_2$

1100 1101

12 = C 13 = D

Therefore, the hexadecimal equivalent of $(0.11001101)_2 = (0.CD)_{16}$

Octal Number System to other Systems

Octal to Decimal

For converting the octal number to its decimal equivalent, each digit is multiplied by its respective position weight, and then added, to get the desired octal number. See the following example.

$(349)_8$

3	4	9
$8^2 = 64$	$8^1 = 8$	$8^0 = 1$
192	32	9

= 192 + 32 + 9

$= (233)_8$

For converting the fractional octal number to its decimal equivalent, each digit is multiplied by its respective position weights (i.e. the negative powers of the radix 8), and then added together to get the result. See the following example.

$(0.265)_8$

$$= 2 \text{ x } 8^{-1} + 6 \text{ x } 8^{-2} + 5 \text{ x } 8^{-3}$$

$$= 2/8 + 6/64 + 5/512$$

$$= (0.353515625)_{10}$$

Therefore $(0.265)_8 = (0.353515625)_{10}$

For converting the octal number to a binary number, it has first to be converted into decimal form and then to binary form. See the following example.

$(243)_8$

Convert the above given octal number to decimal form first:

$(243)_8 \qquad = 2 \text{ x } 8^2 + 4 \text{ x } 8^1 + 3 \text{ x } 8^0$

$= 2 \text{ x } 64 + 4 \text{ x } 8 + 3 \text{ x } 1$

$= 128 + 32 + 3$

$= (163)_{10}$

Now convert this decimal equivalent to the binary form:

2	163	
2	81	1
2	40	1
2	20	0
2	10	0
2	5	0
2	2	1
2	1	0
	0	1

Thus, the binary equivalent of $(163)_{10} = (10100011)_2$

Therefore, $(243)_8 = (163)_{10} = (10100011)_2$

For converting the octal number to its binary equivalent, it has to be first converted into its decimal form. See the following example.

$(0.25)_8$

$(0.25)_8 \qquad = 2 \text{ x } 8^{-1} + 5 \text{ x } 8^{-2}$

$= 2/8 + 5/64$

$= 21/64$

$= (0.328125)_{10}$

Now convert this decimal number to its binary equivalent:

	Fraction	Integer
0.328125 x 2 = 1.3125	0.3125	1
0.3125 x 2 = 1.25	0.25	1
0.25 x 2 = 0.50	0.50	0
0.50 x 2 = 1.00	0.00	1

Thus, the binary equivalent of $(0.328125)_{10}$ is $(0.1101)_2$

Therefore, $(0.25)_8 = (0.328125)_{10} = (0.1101)_2$

Hexadecimal System to other Systems

Hexadecimal to Decimal

Each digit of the hexadecimal number is multiplied by its respective position weight, and then added, to get the number in the proposed system. See the following example.

$(E28B)_{16}$

E = 14	2	8	B = 11
16^3 = 4096	16^2 = 256	16^1 = 16	16^0 = 1
14 x 4096	2 x 256	8 x 16	11 x 1
57344	512	128	11

$= 57344 + 512 + 128 + 11$

$= (57995)_{10}$

Therefore, $(E28B)_{16} = (57995)_{10}$

Hexadecimal to Binary

1st Method

A hexadecimal number can be converted to its binary equivalent by first converting it to the equivalent decimal number, and then further converting the resultant decimal number to the binary number. See the following example.

$(C3B1)_{16}$

Convert $(C3B1)_{16}$ to its equivalent decimal form:

1 x 16^0 = 16

B x 16^1 = 176

3 x 16^2 = 768

C x 16^3 = 49152

50112

Thus $(C3B1)_{16}$ = $(50112)_{10}$

Now convert this decimal form to its equivalent binary form:

2	50112	
2	25056	0
2	12528	0
2	6264	0
2	3132	0
2	1566	0
2	783	0
2	391	1
2	195	1
2	97	1
2	48	1
2	24	0
2	12	0
2	6	0
2	3	0
2	1	1
	0	1

Thus, the binary equivalent of $(50112)_{10}$ is $(1100001111000000)_2$

Therefore, $(C3B1)_{16}$ = $(50112)_{10}$ = $(1100001111000000)_2$

2nd Method

The hexadecimal number is first converted into its decimal equivalent, and then the decimal number so obtained is further converted to a group of binary digits. It uses the group of four bits to represent a single number

Hexadecimal	C	3	B	1
Decimal	12	3	11	1
Binary Position	23 22 21 20	23 22 21 20	23 22 21 20	23 22 21 20
Binary Number	8 4 2 1	8 4 2 1	8 4 2 1	8 4 2 1
	1100	0011	1011	0001

ERROR DETECTING CODES

When a user types some data through the keyboard, typing errors may occur. Detection of errors during typing the data is essential to avoid delays and difficulties. Hence, it is necessary to design a code, such that, if there is an error in the code, it can be detected during data entry by a simple program. Practically it is not possible to design a code so that an arbitrary error is detected. A code can be designed if the types of errors normally committed in data entry are known. Then the code will be able to detect all such errors.

Type of error	Example	Occurrence
Single transcription error (one digit incorrectly typed)	45687 → 49687	86
Transposition error	96845 → 96485	9
(Two digits are interchanged)	96845 → 94685	
All other errors		5

If a code is designed which is able to detect the two types of common errors – single transcription and transposition errors – it would be good. Such a code has been designed which is known as modulus 11 code.

Constructing Modulus-11 Codes

Let us construct a modulus -11 code for 34718.

- Multiply the least significant digit by 2.
- Multiply the digit to its left by 3.
- Multiply the digit to its left by 4 and so on.
- Add the products.
- Divide the weighted sum of digits by 11.
- Append 11 – remainder to the right of the code.
- This is the new code to be used.

After operating this rule on the given code 34718:

$$= 3 * 6 + 4 * 5 + 7 * 4 + 1 * 3 + 8 * 2 = 85$$

Weights

Now,

85 mod 11 = 8

So, append 11 – 8 = 3 to the code and get the new code 347183. The remainder 3 appended to the code is called check digit.

If the remainder after division is 1, then

11 – 1 = 10

In this case, the character 'X' is appended to the code.

If the remainder after division is 0, then 0 is appended to the code.

For example,

If the given code is 45687, then

> 4 * 6 + 5 * 5 + 6 * 4 + 8 * 3 + 7 * 2 = 111
>
> 111/11 = quotient = 10 remainder = 1
>
> Digit to be appended (11 – 1) = 10. Use X to represent 10
>
> 45687 <u>X</u>

Similarly, for the code 68748

> 6 * 6 + 8 * 5 + 7 * 4 + 4 * 3 + 8 * 2 = 132
>
> 132/11 = quotient = 12 remainder = 0
>
> Digit to be appended will be 0.
>
> 45687<u>0</u>

The modulus–*N* check can be generalized for non-numeric codes. If a code is constructed with 10 decimal digits and 26 letters of the English alphabet, then the value of *N* should be a prime greater than 36. The number 37 is prime. Hence, modulus–37 check is suitable for alphanumeric codes.

REVISION EXERCISES

1. Convert the decimal number 250.5 into octal and hexadecimal numbers.
2. Convert the following decimal numbers to binary ones:
   a. 12.0625

b. 673.23

c. 10000

d. 1998

3. Convert $(225.225)_{10}$ to binary, octal and hexadecimal.

4. Convert $(11010111.110)_2$ to decimal, octal and hexadecimal.

5. Convert $(623.77)_8$ to decimal, binary and hexadecimal.

6. Convert $(2AC5.D)_{16}$ to decimal, octal and hexadecimal.

7. Convert the following binary numbers to decimal numbers:

a. 10.10001

b. 101110.0101

c. 1110101.110

d. 1101101.111

8. Add a modulus-11 check digit to the codes

a. 48467

b. 96432

c. 87646257

Answers

1. a. $(372.4)_8$

   b. $(FA.8)_{16}$

2. a. 1100.0001

   b. 1010100001.00111

   c. 10011100010000

   d. 11111001110

3. $(225.225)_{10}$ $(11100001.001110011)_2$

   $(341.16314)_0$ $(E1.399)_H$

4. $(215.75)_{10}$ $(11010111.110)_2$

   $(327.6)_0$ $(D7.C)_H$

5. $(403.9843)_{10}$ $(110010011.111111)_2$

$(623.77)_0$ $(193.FC)_H$

6. $(10949.8125)_{10}$ $(10101011000101.1101)_2$

$(25305.64)_0$ $(2AC5.D)_H$

7. (a) 2.53125 (b) 46.3125

(c) 117.75 (d) 109.875

8. (a) 484673 (b) 964323

(c) 876462578

Chapter 3: INPUT AND OUTPUT DEVICES

INPUT UNITS

Data must be entered into a computer before processing may take place. You can enter data into the computer in many ways. A device that allows the user to enter data into a computer is called an input device. Most commonly used input devices are keyboards; pointing devices such as mouse and track balls; and scanners. Many other special-purpose input devices are also available. Computers often have more than one input device attached. For example, most personal computers have both a keyboard and a mouse.

Keyed Input

Most input data is entered into the computer by using a keyboard. This input method is similar to typing on a typewriter.

Most typewriters and computer keyboards are QWERTY keyboards. The alphabetic keys are arranged in a manner so that the upper-left row of letters begins with the six letters Q W E R T Y. Designers of other keyboards claim that their boards are easier to learn than the QWERTY keyboard. The Dvorak keyboard is one example. It is not widely accepted, however, because most people have already learned the QWERTY keyboard.

In different parts of the world, we find different keyboards. The coding used on the QWERTY and Dvorak keyboards works with an 8-bit code, which accommodates 256 different characters. Asian languages have many more characters. The Kanji alphabet, for example, has 50,000 characters. Japanese keyboards have to work with a 16-bit code to accommodate all the characters.

Computer keyboards also include keys that are designed to perform specific tasks instead of entering characters only. These special keys include function keys, directional keys and special-purpose keys such as Alt, Ctrl, Enter, Ins, and Esc. These keys enable the user to perform complex tasks easily when using the application. For example, many applications use a function key to access online help for the user.

Some new keyboards have even 110 keys, with three new keys designed to simplify working with Windows operating systems. Two of these keys, next to the Alt key, bring up the Start menu. The third key, next to the right Ctrl key, brings up a menu of functions that are frequently accessed in whichever application is currently being used.

Prolonged keyboard use can cause wrist problems, sometimes so serious as to require surgery. To help prevent these problems, ergonomic keyboards have been introduced in the market.

One special type of keyboard construction is the MEMBRANE-SWITCH KEYBOARD, in which a protective film covers the keyboard. Membrane-switch keyboards are reliable, durable and resistant to such hazards as liquids or grease. However, membrane keys require more pressure than keys on a standard computer keyboard. You have probably seen membrane-switch keyboards in fast-food restaurants. Membrane-switch keyboards are ideal in situations that require little actual keying.

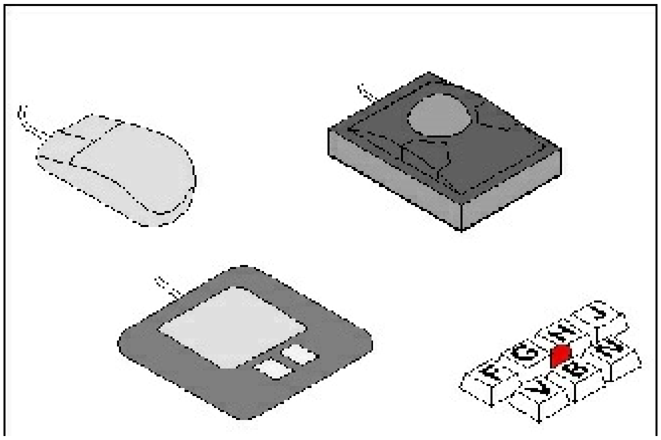
Many computer systems are designed for SOURCE-DATA AUTOMATION. These systems place keyboards and display units at the most convenient spot for data entry. An example is the use of Point-of-Scale (POS) cash registers in retail stores. POS registers send data directly to a computer file for later processing. This technique has an advantage, because most so-called computer errors are actually keying errors. Capturing data at the source minimizes errors, because the people who key in the data are doing a variety of tasks and are, therefore, less likely to make errors due to boredom or loss of concentration.

A tiny chip, called the keyboard controller, detects that a key has been pressed. The keyboard controller places a code into a part of its memory, called the keyboard buffer, indicating which key is pressed. This code is called the keys scan code. The keyboard controller then signals to the computer's system software that something has happened at the keyboard. It does not specify what has occurred, just that something has. The signal that the keyboard sends to the computer is a special kind of message called an interrupt request. The keyboard controller sends an interrupt request to the system software when it receives a complete keystroke. For example, it you type the letter 'D' the controller immediately issues an interrupt request.

When the system software receives an interrupt request, it evaluates the request to determine the appropriate response. When a key press has occurred the system reads the memory location in the keyboard buffer that contains the scan code of the key that was pressed. It then passes the key scan code to the CPU.

Pointing Devices

Wherever possible many people use pointing devices instead of keyboards . An input device is used to move the pointer (cursor) on screen. Pointing devices minimize the amount of typing (consequently, the number of errors). Movements of the pointing device are echoed on the screen by movements of the mouse pointer and by other visual changes. The many pointing devices available include the mouse, the trackball, the light pen, the digitizing tablet, the touch screen and the pen- based systems. Some of them are shown below.



Major Pointing Devices: Clockwise from the upper left are the mouse, the trackball, the pointing stick (red tip) and the touchpad.

Mouse and Track Ball

The MOUSE is a palm-sized device with a ball built into the bottom. The mouse is usually connected to the computer by a cable (computer wires are frequently called cables) and may have from one to four buttons (usually two). A mouse may be mechanical or optical and comes in many shapes and sizes. When you move the mouse over a smooth surface, the ball rolls, and the pointer on the display screen moves in the same direction. Apple Macintosh, with its graphical user interface, made the mouse popular. Today, most microcomputer systems, regardless of the manufacturer, use a mouse. With the mouse you can draw, select options from a menu, and modify or move text. You can issue commands by pointing with the pointer and clicking a mouse button. In addition to minimizing typing errors a mouse makes operating on a microcomputer easier for the novice. The underside of the mouse houses a device that detects the movement of the mouse relative to the flat surface on which it sits. The 2D motion of the mouse is typically translated into the motion of a cursor on the display.

A mouse is so called, primarily because the cord on early models resembled the rodent's tail, and also because the darting motion of the pointer on the screen appears to be mouse like.

Operating a mechanical mouse. 1. Pulling the mouse turns the ball. 2. The X and Y rollers grip the ball and transfer the movement. 3. The optical encoding disks include light holes. 4. The infrared LEDs shine through the disks. 5. The sensors then gather the light pulses to convert to X and Y velocities.

How does a Mouse Work?

The most common type of mouse has a ball inside it that extends just below the housing. When you slide the mouse around on a flat surface, such as the desktop or a mouse pad, the ball rolls.

On two sides of the ball, at 90 degrees angle from each other, are two small rollers that touch the mouse and spin when the ball rolls. A sensor detects how much each roller spins and sends this information to the computer. The computer translates the information and changes the position of the on-screen pointer to correspond to the position indicated by the mouse.

Like the keyboard, the mouse does not send a message directly to the program that the computer is running. Rather, it sends an interrupt request to the CPU. The program that is running checks regularly to see whether a mouse has been used; if it has, the program reads a memory location to see what has happened, and then reacts appropriately.

Like all input devices, the mouse needs some connection to the host computer in order to transmit its input. Typically the mouse uses a thin electrical cord (e.g. an RS-232, ADB or USB cable) for this purpose. It was most likely the combination of the tail-like cord, its size, and shape, which led the inventors of the mouse to name it as such. Cordless ("tail-less") mice use wireless communication to transmit data via infrared, radio or Bluetooth.

There are several other methods of using a mouse apart from the most basic movement of the device to make a cursor move. A mouse click is the action of pressing and releasing (i.e. 'clicking') a button on a mouse in order to trigger an action, usually in the context of a Graphical User Interface (GUI), as in pressing an onscreen 'button' by 'clicking' on it, or in a computer game to fire a gun in a first-person shooter. The clicking noise is made due to the specific switch technology used nearly universally in computer mice. This switch, called a micro switch or a cherry switch, uses a stiff but flexible metal strip that is bent to actuate the switch. The bending of the metal makes a snapping or clicking noise in the same way as the safety button does on the lids of vacuum-packaged jars to indicate that they have been opened.

Single Clicking

It is the most common method of distinguishing mouse-based input. On a single-button mouse this involves using the mouse's one button. On the multiple-button mouse, it involves any one of the buttons, and is usually characterized by which button is pushed (e.g. left-clicking, right-clicking).

Double Clicking

A double-click occurs when the user presses the button twice in quick succession. This triggers an action separate from that of a single-click. For example, in the Macintosh Finder, the user single-clicks to select a file, and double-clicks in order to open that file. Usability studies have found that the double-click can be confusing and hard to use — for example, users with poor motor skills may not perform the second click fast enough, with the result that the action is interpreted as two single-clicks rather than a double-click. Ironically, the double-click was introduced because the previous solution — separate mouse buttons for separate actions — was also found to be confusing in user studies. Most multiple-button mice allow setting one button to emit a double click on a single press.

Triple-click

A triple-click occurs when the user presses the button three times in quick succession. This also triggers an action separate from that of a single click. It is most commonly seen in word processors to select a whole paragraph and in web browsers to select a whole line of text.

Click-and-Drag

A user "drags" a mouse by depressing and continuing to hold down a mouse button while moving the mouse across the surface.

A TRACK BALL is like an upside-down mouse. Used in the same way as the mouse, the trackball is frequently attached to or built into the keyboard. It is a pointing device consisting of a ball housed in a socket which contains sensors to detect the rotation of the ball on two axes—like an upside-down mouse, but with the ball sticking out more. The user rolls the ball with his thumb, finger, or the palm of his hand to move the cursor. Trackerballs are common on CAD workstations for ease of use, and also on modern portable computers, where there may be no desk space on which to use a mouse. Some trackballs clip onto the side of the keyboard and have integral buttons, which have the same function as mouse buttons. The main advantage of a track ball is that it requires less desk space than a mouse. Some individuals in the computer industry believe that devices that do not require as much space to use will soon replace the mouse.

Logitech Marble Mouse Trackball

A mouse is not a practical option for people using a laptop computer in a small space. Early alternatives, such as trackballs clipped to the side of the keyboard, have not proved satisfactory either. The Apple PowerBook uses a central trackball. The IBM ThinkPad replaces the trackball with a red plastic button, called a trackpoint, located in the middle of the keyboard. You move the button with your thumbs. The newest Apple PowerBooks have a small square of plastic on the front of the keyboard which moves easily to control the pointer.

Touchpad

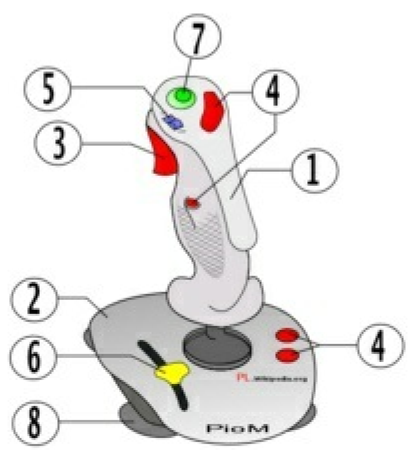
The TOUCH PAD is a stationary pointing device that many people find less tiring to use than a mouse or a track ball. The movement of a finger across a small touch surface is translated into cursor movement on the computer screen. The touch sensitivity surface may be just 1.5 – 2 inch square, so the finger does not have to move much. Its size makes it most suitable for notebooks and laptops.

Joysticks

A JOYSTICK is a pointing device often used for playing games. It has a gearshift-like lever that is used to move the pointer on the screen. On most joysticks, a button on the top is used to select an option. In industry and manufacturing, joysticks are used to control robots. Flight simulators and other training simulators also use them. Most joysticks are two-dimensional, having two axes of movement, just like a mouse, but three-dimensional joysticks also exist.

Joysticks are often used to control games, and usually have one or more push buttons whose state can also be read by the computer. Most I/O interface cards for PCs have a joystick (game control) port. Modern joysticks generally use a USB interface for connecting to the PC.

An analog one is one that has continuous states, i.e., it returns an angle measure of the movement in any direction in the plane or the space. On the other hand, a digital joystick gives only on/off signals for four different directions, and for mechanically possible combinations (such as up-right, down-left). Additionally, joysticks often have one or more *fire buttons*, which are used to trigger some kind of action. These are digital.



Joystick elements: 1. Stick 2. Holder 3. Fire button 4. Extra buttons 5. Autofire switch 6.Throttle 7. Hat Switch 8. Sucker

Touch–sensitive Screens

Perhaps the easiest way to enter data is with the touch of a finger. TOUCH SCREENS enable the user to select an option by pressing a specific part of the screen. Touch screens are commonly used in grocery stores, fast-food restaurants and information kiosks.

Pen–based Systems

Pen–based Systems are especially useful for people who do not like to type or for those who are frequently on the move. PERSONAL DIGITAL ASSISTANTS (PDA), such as the Apple Newton, are designed for people on the go. The Newton can link entries with data on stored files. For example, if you write, "Call Annie and Wish Happy Birthday", the Newton adds a line to your "To do" list and links Annie's phone number from your telephone directory. If your friend Ken moves, you can simply change his address and phone number. The Newton serves equally well as a calendar, a calculator and a notepad.

Pen-based systems are not perfect—they do not always register handwriting correctly. Pen-based computing is just beginning to gain widespread acceptance. For example, many stores no longer ask you sign a carbon form to charge a purchase; instead you sign on a tablet that automatically records your signature.

Many engineers and architects use a different type of pen called a LIGHT PEN. The light pen uses a photoelectric (light sensitive) cell to indicate the screen position to the computer. You operate the pen by touching it to the screen. Light pens are frequently used for Computer-Aided Design (CAD) applications.

Another tool used in CAD and other graphics applications is a digitizing tablet. A DIGITIZING TABLET consists of a grid on which designs and drawings can be entered. Most tablets are pressure-sensitive and the user draws directly on the tablet using a special pen called a **STYLUS** or a puck. Digitizing tablets are used to design cars, buildings, medical devices and robots.

DATA SCANNING UNITS

Optical Recognition Systems (ORS)

Optical Recognition Systems provide another means of minimizing keyed input by capturing data at the source. These systems enable the computer to "read" data by scanning printed text for recognizable patterns.

In the 1950s, the banking industry developed one of the earliest scanning systems for the purpose of processing cheques. The Magnetic Ink Character Recognition (MICR) system is still used throughout the banking industry. The bank, branch, account number and cheque number are encoded on the cheque before it is sent to the customer. After the customer has used the cheque and it comes back to the bank, all that needs to be entered manually is the amount. MICR has not been adopted by other industries because the character set has only fourteen symbols.

Bar Code Readers

Of all the scanning devices, you are probably most familiar with BAR CODE READERS. Many retail and grocery stores use some form of the bar code reader to determine the name of the item being sold and to retrieve its price from a computer system. The code reader may be a hand-held unit or it may be embedded in a countertop. The bar code reader reads the Universal Product Code (UPC), a pattern of bars printed on merchandise. The UPC has gained wide acceptance since its introduction in the 1970's. Initially, workers resisted the use of the code because the system was used to check their accuracy and speed. Today, bar codes are used to update inventory and ensure correct pricing. Federal Express uses a unique bar code to identify and track each package. Federal Express employees can usually tell a customer within a matter of minutes the location of any package.

Many different types of barcode scanners are available. They can be distinguished in the following manner.

- By light source:

  LED scanners, also referred to as **CCD scanners** — even if the CCD is in fact the photo conductor.

  Laser scanners, much more expensive than LED scanners, but capable of scanning barcodes at a distance of up to 25cm (~10")

- By housing:

  Hand-held scanner with a handle and, typically, a trigger button for switching on the light source

Pen scanners (or **wand scanners**), a pen-shaped scanner that is swiped across a barcode

Stationary scanners, wall or table-mounted, under or beside which the barcode is passed. These are commonly found at the checkout counters of supermarkets and other retailers.

Optical Mark Readers

You would probably be familiar with Mark Sense Character Recognition systems if you have ever taken a written examination of the "fill in the bubble" type. Such forms are called Scantron forms. They use a #2 lead pencil; you darken the circular area with the pencil creating input suitable for an OPTICAL MARK READER (OMR). A #2 lead pencil works best because of the number of magnetic particles in that weight lead. The OMR senses the darkened marks, enabling the reader to determine which responses are marked. OMR is very helpful for researchers who need to tabulate responses to large surveys. Almost any type of survey or questionnaire can be designed to be suitable for OMR devices. An OMR unit can be attached to a microcomputer and the data transferred to a file directly.

Optical Scanners

OPTICAL SCANNERS can scan typed documents, pictures, graphics or even handwriting into a computer. Photographs scanned into a microcomputer appear clearly on the screen and can be displayed whenever desired. The copy that the computer stores never yellows with age. Early scanners could recognize only text printed in a special OPTICAL CHARACTER RECOGNITION (OCR) typeface. A scanner converts the image that it sees into numeric digits before storing it in the computer. This conversion process is known as DIGITIZING.

Depending on the volume and type of material to be scanned, you can use a drum scanner, a flatbed scanner, a sheeted scanner or even a small handheld scanner. The small, handheld scanners (priced at about $150) are used most frequently with microcomputers; however, only 5 per cent of all microcomputer systems are equipped with scanners. In 1995, manufacturers responded to user-reluctance to scanners by releasing a number of new, small paper scanners priced between $200 and $500. In 1994, full-page scanners cost between $500 and $700. Most of these new devices sit between the keyboard and the monitor and can interface with a fax machine, send e-mail, and store documents on the disk for archive purposes.

Voice Recognition Devices

Voice input and control systems have the potential of revolutionizing the way we communicate with computers. Steady progress has been made in this area, although some problems still exist. The day may soon come when we will be able to talk to our computers the way the actors do in sci-fi movies like Star Trek.

Computer scientists and linguists have been working on VOICE RECOGNITION SYSTEMS for two decades. The major difficulty has been that different people speak with different accents and intonations. For this reason, most successful voice recognition systems require a period of "training" for the system to get accustomed to an individual's accent and intonation.

The first few systems could recognize only a few dozen words. A system recently released by IBM, known as Voice Type, is capable of recognizing as many as 32,000 words and is speaker-independent.

Voice recognition has unlimited possibilities and will make computers much easier to use. Speech recognition systems are already being used in many types of settings. In factories, workers use speech recognition systems to control robotic arms when the worker's own hands are busy. Speech recognition systems enable physically disabled people to use computers. A microcomputer Voice User Interface (VUI), capable of recognizing input from a variety of individuals, will be considered standard soon.

VIDEO DIGITIZERS can capture input from virtually any type of video device, such as VCRs, television and camcorders. Audio digitizers can digitize music or voice from a microphone. It is fairly easy to capture a portion of a television show, add some music that complements the picture and play back the result on a microcomputer to create a multimedia presentation.

OUTPUT UNITS

Output devices are varied and as innovative as input devices. From traditional printed output to audio output and robots, there is a multitude of forms of computer output.

Most output can be divided into two categories: soft copy and hard copy. Soft copy is ideal when you are writing a document, playing a game, watching a video clip, or reading the latest news. Soft copy is what you see on the monitor. It is temporary; after you have finished with it, there is nothing solid to hold. You can, however, transfer soft copy to a disk to transport it. Hard copy on the other hand, can be touched and carried. It is usually some form of paper output. It is especially helpful if you need to have a colleague look at your work or you need to give your work to a supervisor or a teacher.

Monitors

When you think about viewing computer output, you probably visualize a monitor. Monitor output is soft copy; when you have finished viewing it, you cannot move it. Monitor displays are the most common form of soft copy.

Sometimes when watching television, you may notice that the picture looks a little snowy. This condition occurs because the images are not solid but rather created by configurations of dots. These dots, or picture elements, combine to form the image you see. The more picture elements, also known as pixels, there are the better is the resolution of the image. The better the resolution, the clearer is the picture. Computer monitors are similar to television screens.

The large monitors that you see connected to desktop computers are Cathode-Ray Tube (CRT). Monitors that are used on laptops and notebook computers are known as flat-panel displays. Flat-panel displays weigh less and consume less electricity than CRTs. Common types of flat-panel displays include Liquid Crystal Displays (LCDs), Electro Luminescent (EL) displays and Gas Plasma (GP) displays. Flat-panel display monitors are still more expensive than CRTs, but eventually their prices are expected to decrease. (PixelVision recently released a 16-inch flat-panel display that includes a two million-color palette and sells for $10,000.) Can you imagine monitor hanging on the wall like a painting? It may be common in a few years.

Most new monitors are SVGA (Super Video Graphics Adapters), with a pixel configuration of 800 by 600 at low-resolution mode and 1024 by 768 at high-resolution mode. The first number designates the horizontal pixel, count, and the second is the vertical pixel count. The higher resolution, with more pixels, provides a clearer, more detailed image. Each pixel displays a single color at a time. Each color is represented by a numeric code. For example, bright red could be 12. If the monitor displays only 16 colors, the numeric code can be represented with only four bits. To display 256 colors (each with its own code) requires eight bits.

One monitor may look “sharper” than another, even though they may have the same pixel configuration. This is due to the dot pitch, which is the distance between pixels. A .28 dot pitch gives a crisper image than a .30 dot pitch. The .28 dot pitch is fairly standard. You should consider dot pitch when purchasing a monitor. The dot pitch is built in by the manufacturer and cannot be changed.

With users increasingly viewing video clips, animated objects and complex graphics, monitors have taken on a new importance. Users now must decide how large a monitor they need. Fourteen-inch to seventeen-inch monitors are commonly used with desktop microcomputer systems. Larger monitors are available, but are expensive.

Display in black and white (monochrome) or color categorizes monitors. Monochrome monitors are rapidly becoming a thing of the past, as most applications today require color. In fact, a display of 256 colors is usually necessary for working with informational CD-ROMs and clip-art collections.

In order to connect a monitor to a microcomputer, you must have a graphics adapter board (also known as a video card). Each type of monitor requires a different type of board. The graphics board plugs into an expansion slot inside the computer and the monitor plugs into the board.

In order to run today's graphics-intensive programs properly and quickly, most graphic boards come with some memory capability, known as video memory. It is important to realize that Video RAM (VRAM) must meet higher performance specifications than regular RAM. It is recommended that instead of using RAM on a video card, the user should place VRAM or dynamic RAM (DRAM), which is slightly slower than VRAM, on a video card.

The refresh rate of a monitor is also important and is affected by the video card. Even a steady image is constantly regenerated, or refreshed, from top to bottom. A slow refresh rate of 60 times per second (60Hz) can cause headache; 70Hz is a reasonable minimum. Some monitors, known as interlaced monitors, refresh every other line; non-interlaced monitors are easier on the eyes. The Motion Picture Expert Group (MPEG), has developed standards for video compression that improve the quality of the video on the monitor. MPEG drivers are available as software or as hardware (built-in video card).

Audio Output

Have you ever listened to a concert or watched a television show on a computer? Audio output is the second type of softcopy. New computer systems have such good audio systems that it is possible to listen to music while you work, have the computer tell you when the printer needs paper, play games that include sound, or compose music on the computer. In order to have high quality audio output, a good quality sound card as well as good speakers are needed.

New sound cards even include the capability to have the computer read a text file to you while you continue working on a different application. Voice input and output has proved helpful to individuals with speech and vision impairments. People with speech impairment can key a message into a computer and have the computer repeat it. Of course, computer generated voices are not human; they are synthesized. Speech synthesis, having the computer speak, is a much simpler process than speech recognition.

Printers

The second most common form of computer output is the printed document. Although a computer can operate perfectly well without a printer, it is certainly helpful for the user to have one. Because you can hold printed output, it is considered a form of hard copy.

Printers can be categorized by whether anything mechanical touches the paper; whether they do or do not produce a solid character or how many pages or a line, or a character they produce, at a time.

When a part of the printer presses the paper to form the character, the printer is considered an impact printer. Impact printers can produce carbon copies and are fairly loud, although covers are available to muffle the noise. In contrast, non-impact printers are quiet. However, because nothing presses on the page, a non-impact printer cannot produce carbon copy. This fact is usually not a problem because it is easy to produce multiple originals, but sometimes carbons are required for legal purposes.

Impact Printers

Impact printers can produce a page, a line, or a character at a time. Large computers use line printers. The main drawback of line printers is that they can produce only text and no graphics.

Many small computers use character printers. Although only one character can be produced at a time, many types of character printers can produce graphics as well as text. The most common character printers create images by using a dot pattern. These printers are known as dot matrix printers. If you use a magnifying glass to look at a report created with a DOT MATRIX PRINTER, you can see the small dots forming each character.

LINE MATRIX is a type of line printer that uses an oscillating row of print hammers. The hammers form characters and graphics by impacting a ribbon and transferring dots of ink onto the paper. An impact printer is the one that prints a line at a time. Printronix pioneered this technology in 1974.

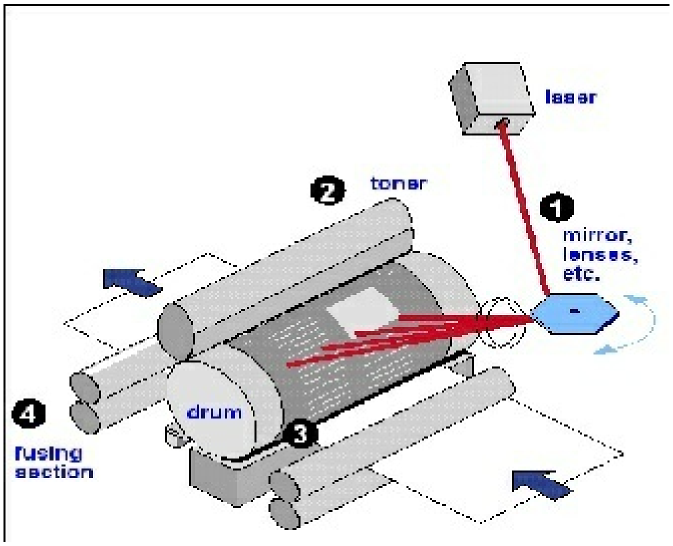
BAND (LINE CHARACTER) is a type of line printer that uses a fixed set of characters attached to a continuously revolving metal band. A set of hammers (one for each column) hit the paper, pushing it into the ribbon and against the character image on the band.

Non-impact Printers

Non-impact printers are increasing in popularity largely because of improvement in print quality coupled with decreasing cost. Non-impact printers can produce both text and graphics. Because nothing actually strikes the paper, non-impact printers are fairly quiet. Some of the most popular non-impact printers are laser printers and inkjet printers.

Laser Printers

Laser printers work in the same manner as copy machines. A laser beam creates electrical charges that attract the toner to form an image and transfer it to paper. A printer uses the laser and the electrophotographic methods to print a full page at a time. The laser is used to “paint” a charged drum with light, to which the toner is applied and then transferred onto paper. Laser printers come in a variety of sizes; generally the larger and faster the printer, the more expensive it is. Large laser printers are used on mainframes and minicomputers where high quality graphic output is required. Small, “personal” laser printers are suitable for home use. Hewlett Packard recently began production of wireless printers. The HP5P (IBM) and HP5PM (Mac) enable the user to beam a document from the laptop to an infrared receiver in the front of the printer. The laptop needs to have a built in infrared transmitter installed, but no cables or wires are required.



The Laser Mechanism: The laser printer uses electrostatic charges to (1) create an image on the drum, (2) adhere the toner to the image, (3) transfer the toned image to the paper, and (4) fuse the toner to the paper. The laser creates the image by "painting" a negative of the page to be printed on the charged drum. Where light falls, the charge is dissipated, leaving a positive image to be printed.

Inkjet Printers

Inkjet printers are also popular among microcomputer users. Although the resolution is lower on inkjet printers than on laser printers, it is higher than that of dot matrix printers. Inkjet printers are significantly less expensive than laser printers. Electronically charged ink is sprayed through a jet nozzle and passed through an electronic field, which deflects the ink to form a dot matrix character. Color inkjet printers, which use multiple nozzles, are available at very reasonable prices. Canon recently released a color inkjet printer that weighs 3 pounds and stands 2 inches high. The perfect choice of printer while traveling!

A well-equipped office at home or at workplace includes an inkjet printer, a fax machine (with its own telephone), a copier and a full sheet scanner. A recent addition to the market is one device that does all four functions. The technology to print a document that has been faxed to you and the technology to copy a document are similar to the technology to print a document from a PC. All three technologies use similar digital patterns and the mechanical aspects are nearly identical.

Other high quality printers include Thermal-wax printers, Dye-sub printers, Fiery printers and IRIS printers.

The thermal-wax printers are primarily used for presentation graphics and handouts. They operate with a ribbon-coated pane of colored wax that melts and adheres to plain paper as colored dots passed over a focused heat source. As the paper and ribbon travel in unison beneath the thermal print head, the wax-based ink from the transfer ribbon melts onto the paper. When cool, the wax is permanent. This type of thermal printer uses a like-size panel of ribbon for each page to be printed, regardless of the contents of the page. Monochrome printers have a black panel for each page to be printed, while color printers have either three (CMY) or four (CMYK) colored panels for each page.

The dye-sub printer is a printer that produces continuous-tone images that look like a photographic film. It uses a ribbon containing an equivalent panel of dye for each page to be printed. Color printers have either three (CMY) or four (CMYK) consecutive panels for each page, thus the same amount of ribbon is used to print a full-page image, as it is to print a tenth of the page. Special dye-receptive paper is used, and the consumables (ribbon and paper) cost more than other printer technologies.

The paper and ribbon are passed together over the print head, which contains thousands of heating elements that can produce varying amounts of heat. The hotter the element, the greater is the amount of dye released. By varying the temperature, shades of each color can be overlaid on top of each other. The dyes are transparent and blend into a continuous-tone color.

Fiery printer servers are special type of computers that transmits documents to a digital color copier, where they are printed.

IRIS printers are large-format color printers from the Iris Graphics division of CreoScitex, that are used for digital proofing. Iris printers use a patented continuous inkjet technology to produce consistent, continuous-tone, photo-realistic output on several varieties of paper, canvas, silk, linen and other low-fiber textiles. Iris prints are widely noted for their color accuracy and ability to match printing and proofing standards. They are also known for their low-cost consumables as compared to other technologies.

Plotters

A plotter, like a printer, produces hard copy output. Plotters, which produce high quality color graphics, are usually categorized by whether they use pens or electrostatic charges to create images. A continuous curve plotter is used to draw maps from stored data. Computer generated maps can be retrieved and plotted or used to show changes over time. Plotters are generally more expensive than printers, ranging from about $1,000 to $75,000 (or even more).

A plotter uses a robotic arm to draw with colored pens on a sheet of paper. The instructions that a plotter receives from the computer consists of the color and the beginning and ending coordinates for a line. With this information, the plotter picks up the appropriate pen, positions it at the beginning of the coordinates drops the pen down to the surface of the paper and draws to the ending coordinates. The plotter draw curves by creating a sequence of very short, straight lines.

REVISION EXERCISES

Fill in the blanks

1. .... cannot produce multiple copies.
2. The capability of a computer to understand verbal instructions is called.........
3. ....produces high-quality graphics.
4. .... keyboard is most commonly used.
5. .... can be used to input the picture in the computer.
6. ....displays the soft copy.
8. ....printers use infra-red receiver to receive a document
9. The banking industry uses ....
10. Personal computers use .... and .... input devices, most commonly.
11. ....keyboards are resistant to liquids and grease.
12. .... are the smallest types of computers.

Answers

1. Non-impact Printers 2. Voice recognition 3. Plotter

4. QWERTY 5. Scanner

6. Monitor 7. Wireless

8. MICR

9. Keyboard, Mouse

10. Membrance Switch

11. Personal Digital Assistants

REVIEW QUESTIONS

1. List four types of output devices.
2. Describe various types of input devices and differentiate amongst them.

3. Write about various types of scanners.
4. What is the difference between impact and non-impact printers?
5. Write a note on trackballs.
6. What is an MICR?
7. Why are Personal Digital Assistants becoming popular?
8. Write a brief on all the types of input devices.
9. Write a note on scanning devices.
10. What do you think can come after voice recognition devices?

Chapter 4: COMPUTER MEMORY

THE MAIN MEMORY UNIT

The main memory, also known as the primary memory, is a part of the central processing unit and is a combination of both RAM (Random Access Memory) and ROM (Read Only Memory).

RANDOM ACCESS MEMORY

The random access memory is a read-write memory i.e. information can be read as well as written into this type of memory. It is volatile in nature, i.e., the information it contains is lost as soon as the system is shut down, unless it is ‘saved’ by the user for further usage. It is basically used to store programs and data during the computer’s operation.

RAM Basics

A memory chip is an Integrated Circuit (IC) made of millions of transistors and capacitors. In the most common form of computer memory, Dynamic Random Access Memory (DRAM), a transistor and a capacitor are paired to create a memory cell, which represents a single bit of data. The capacitor holds the bit of information - a 0 or a 1. The transistor acts as a switch that lets the control circuitry on the memory chip read the capacitor or change its state.

For dynamic memory to work, either the CPU or the memory controller has to come along and recharge all of the capacitors holding a 1 before they discharge. To do this, the memory controller reads the memory and then writes it right back. This refresh operation happens automatically thousands of times per second.

This refresh operation is where dynamic RAM gets its name. Dynamic RAM has to be dynamically refreshed all of the time or it forgets what it is holding. The downside of all of this refreshing is that it takes time and slows down the memory.

Memory cells are etched onto a silicon wafer in an array of columns (bitlines) and rows (wordlines). The intersection of a bitline and wordline constitutes the address of the memory cell.

DRAM works by sending a charge through the appropriate column (CAS) to activate the transistor at each bit in the column. When writing, the row lines contain the state the capacitor should take on. When reading, the sense-amplifier determines the level of charge in the capacitor. If it is more than 50 percent, it reads it as a 1; otherwise it reads it as a 0. The counter tracks the refresh sequence, based on which rows have been accessed and in what order. The length of time necessary to do all this is so short that it is expressed in nanoseconds (billionths of a second). A memory chip rating of 70ns means that it takes 70 nanoseconds to completely read and recharge each cell.

Memory cells alone would be worthless without some way to get information in and out of them. So the memory cells have a whole support infrastructure of other specialized circuits. These circuits perform functions such as:

- Identifying each row and column (row address select and column address select)
- Keeping track of the refresh sequence (counter)
- Reading and restoring the signal from a cell (sense amplifier)
- Telling a cell whether it should take a charge or not (write enable)

Other functions of the memory controller include a series of tasks that include identifying the type, speed and amount of memory, and checking for errors.

Static RAM uses a completely different technology. In static RAM, a form of flip-flop holds each bit of memory. A flip-flop for a memory cell takes four or six transistors along with some wiring, but never has to be refreshed. This makes static RAM significantly faster than dynamic RAM. However, because it has more parts, a static memory cell takes up a lot more space on a chip than a dynamic memory cell. Therefore, you get less memory per chip, and that makes static RAM a lot more expensive.

So static RAM is fast and expensive, and dynamic RAM is less expensive but slower. So static RAM is used to create the CPU’s speed-sensitive cache, while dynamic RAM forms the larger system RAM space.

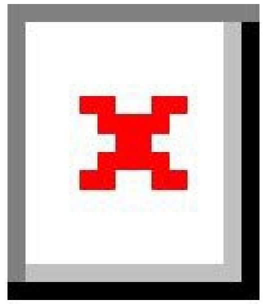
Memory Modules

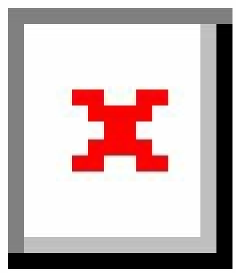
Memory chips in desktop computers originally used a pin configuration called Dual Inline Package (DIP). This pin configuration could be soldered into holes on the computer's motherboard or plugged into a socket that was soldered on the motherboard. This method worked fine when computers typically operated on a couple of megabytes or less of RAM, but as the need for memory grew, the number of chips needing space on the motherboard increased.

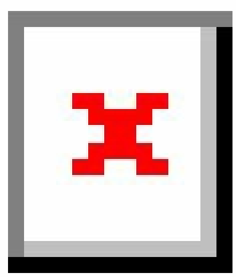
The solution was to place the memory chips, along with all of the support components, on a separate Printed Circuit Board (PCB) that could then be plugged into a special connector (memory bank) on the motherboard. Most of these chips use a Small Outline J-lead (SOJ) pin configuration, but quite a few manufacturers use the Thin Small Outline Package (TSOP) configuration as well. The key difference between these newer pin types and the original DIP configuration is that SOJ and TSOP chips are surface-mounted onto the PCB. In other words, the pins are soldered directly to the surface of the board, not inserted in holes or sockets.

Memory chips are normally only available as part of a card called a module. You've probably seen memory listed as 8x32 or 4x16. These numbers represent the number of the chips multiplied by the capacity of each individual chip, which is measured in Megabits (Mb), or one million bits. Take the result and divide it by eight to get the number of megabytes on that module. For example, 4x32 means that the module has four 32-megabit chips. Multiply 4 by 32 and you get 128 megabits. Since we know that a byte has 8 bits, we need to divide our result of 128 by 8. Our result is 16 megabytes!

The type of board and connector used for RAM in desktop computers has evolved over the past few years. The first types were proprietary, meaning that different computer manufacturers developed memory boards that would work only with their specific systems. Then came SIMM, which stands for single in-line memory module. This memory board used a 30-pin connector and was about 3.5 x .75 inches in size (about 9 x 2 cm). In most computers, you had to install SIMMs in pairs of equal capacity and speed. This was because the width of the bus is more than a single SIMM. For example, you would install two 8-megabyte (MB) SIMMs to get 16 megabytes of total RAM. Each SIMM could send 8 bits of data at one time, while the system bus could handle 16 bits at a time. Later SIMM boards, slightly larger at 4.25 x 1 inch (about 11 x 2.5 cm), used a 72-pin connector for increased bandwidth and allowed for up to 256 MB of RAM.







From the top: SIMM, DIMM and SODIMM memory modules

Common Ram Types

SRAM

Static Random Access Memory uses multiple transistors, typically four to six for each memory cell, but doesn't have a capacitor in each cell. It is used primarily for cache.

DRAM

Dynamic Random Access Memory has memory cells each with a paired transistor and capacitor, requiring constant refreshing.

FPM DRAM

Fast Page Mode Dynamic Random Access Memory was the original form of DRAM. It waits through the entire process of locating a bit of data by column and row and then reading the bit before it starts on the next bit. The maximum transfer rate to L2 cache is approximately 176 MBPS.

EDO DRAM

Extended Data-out Dynamic Random Access Memory does not wait for the entire the processing of the first bit before continuing to the next one. As soon as the address of the first bit is located, EDO DRAM begins looking for the next bit. It is about five percent faster than FPM. The maximum transfer rate to L2 cache is approximately 264 MBPS.

SDRAM

Synchronous Dynamic Random Access Memory takes advantage of the burst mode concept to greatly improve performance. It does this by staying on the row containing the requested bit and moving rapidly through the columns, reading each bit as it goes. The idea is that most of the time the data needed by the CPU will be in sequence. SDRAM is about five percent faster than EDO RAM and is the most common form in desktops today. The maximum transfer rate to L2 cache is approximately 528 MBPS.

DDR SDRAM

Double Data Rate Synchronous Dynamic RAM is just like SDRAM except that is has higher bandwidth, meaning greater speed. The maximum transfer rate to L2 cache is approximately 1,064 MBPS (for DDR SDRAM 133 MHZ).

RDRAM

Rambus Dynamic Random Access Memory is a radical departure from the previous DRAM architecture. Designed by Rambus, RDRAM uses a Rambus

In-line Memory Module (RIMM), which is similar in size and pin configuration to a standard DIMM. What makes RDRAM so different is its use of a special high-speed data bus called the Rambus channel. RDRAM memory chips work in parallel to achieve a data rate of 800 MHz, or 1,600 MBPS. Since they operate at such high speeds, they generate much more heat than other types of chips. To help dissipate the excess heat Rambus chips are fitted with a heat spreader, which looks like a long thin wafer. Just like there are smaller versions of DIMMs, there are also SO-RIMMs designed for notebook computers.

Credit Card Memory

Credit card memory is a proprietary self-contained DRAM memory module that plugs into a special slot for use in notebook computers.

PCMCIA Memory Card

Another self-contained DRAM module for notebooks, a card of this type is not proprietary and should work with any notebook computer whose system bus matches the memory card's configuration.

CMOS RAM

CMOS RAM is a term for the small amount of memory used by the computer and some other devices to remember things like hard disk settings. This memory uses a small battery to provide it with the power it needs to maintain the memory contents.

VRAM

VideoRAM, also known as MultiPort Dynamic Random Access Memory (MPDRAM), is a type of RAM used specifically for video adapters or 3-D accelerators. The "multiport" part comes from the fact that VRAM normally has two independent access ports instead of one, allowing the CPU and the graphics processor to access the RAM simultaneously. VRAM is located on the graphics card and comes in a variety of formats, many of which are proprietary. The amount of VRAM is a determining factor in the resolution and color depth of the display. VRAM is also used to hold graphics-specific information such as 3-D geometry data and texture maps. True multiport VRAM tends to be expensive, so today, many graphics cards use SGRAM (synchronous graphics RAM) instead. The performance is nearly the same, but SGRAM is cheaper.

Read Only Memory (ROM)

The Read Only Memory (ROM) contains non-volatile or permanent information. As the name suggests, the information contained in this type of memory can only be read; it cannot be altered or overwritten. Information is entered into the ROM chip at the time of manufacturing. ROM chips are used for applications which require a permanent information, for example, a program for the functioning of the visual display unit, or a program for controlling the working of a washing machine etc.

With the advent of technology, erasable ROMs have become available. We shall discuss these and other ROM's in the following section.

Types of ROM:

- Programmable Read Only Memory (PROM): A PROM program is used to record information in the PROM chip. Information once programmed into the PROM chip is permanent and cannot be changed or erased. The process of entering the information into the PROM chip is known as "burning the PROM." PROM chips are seldom used in modern day computers, but they still find their use in devices where a permanent ROM is required.

- Masked Read Only Memory (MROM): In the masked ROM, the information is permanently recorded by the masking and metallization process. It is not easy to perform this process as a large infrastructure is required, and, therefore, it is usually the manufacturers who perform this process.
- Erasable Programmable Read Only Memory (EPROM): An EPROM is an erasable PROM. An EPROM can be (re) programmed using an EPROM programmer. Exposing it to high intensity ultraviolet light for 30 minutes (approximately) can erase the contents of an EPROM chip. An ultra-violet source with a wavelength of 2537A (angstrom) is used for this purpose. The process of changing the contents is not convenient, as the chip has to be removed from the board for exposure to the ultra-violet light source. Another disadvantage is that the user can't erase the contents of a single memory location, and the entire memory contents have to be erased. The EPROM chip is cheap, reliable and widely available.
- Electrically Erasable Programmable Read Only Memory (EEPROM): EEPROM is an electrically erasable PROM. The use of electrical signals can alter the information, and so the chip need not be removed from the board. One major advantage that this chip has over the EPROM is that even a single memory can be altered, i.e., the entire memory need not be erased and reprogrammed, unless so required. The change in the contents of the EEPROM chip is made in milliseconds, which is much less than the erasing time for EPROM.
- Non-volatile RAM: A non-volatile RAM combines a static RAM and EEPROM. Such a device operates as normal RAM but, in case of power-failure, the entire contents of the RAM are stored in EEPROM. When the power is restored, the data from EEPROM is transferred back to the RAM.

The main memory is a fast memory, i.e., it has small access time. It is because of its limited capacity that it is fast. The main memory contains the programs that are currently being worked on. It passes on this information to the control unit as and when required. In case the CPU wants to access some data that is present in a secondary storage device, this data is first transferred to the main memory and then processed.

The main memory is for costlier than the secondary storage devices. Although the ROM IC's of various computers do not vary much in their capacities, the RAM chips are available in wide ranges of storage capacities. In fact, the capacity of the random access memory is an important specification of a computer.

A larger RAM means that larger programs (in terms of memory) can be loaded and executed. Suppose you want to run a 68-KB program on a machine with 64-KB. This means that the whole program cannot be loaded into the main memory, at once resulting in either the non-execution of the program or a very slow execution.

A 64-K memory means that there are approximately 64000 (65,536 to be precise) storage locations which can store 1 bit of data each.

Different memories can be classified on the basis of their concepts:

1. Access Mode: which means how easily they are accessible.
2. Access Time: the average time required to reach a storage location and obtain its content is called access time.
3. Transfer Rate: the transfer rate is the number of characters or words that a device can transfer per second after it has been positioned at the beginning of the record.
4. Capacity and Cost: the capacity and cost may depend upon the requirement and the budget.

The main memory has a very low access time and a very high transfer rate. It is limited in capacity and costlier than secondary storage devices.

The Cache Memory

The cache memory lies in the path between the processor and the main memory. The cache memory has lesser access time than the main memory and is faster than the main memory. A cache memory may have an access time of 100ns, while the main memory may have an access time of 700ns.

The cache memory is very expensive and is limited in capacity. Earlier, cache memories were available separately, but the latest microprocessors contain the cache memory on the chip itself.

The need for the cache memory arises because of the mismatch between the speeds of the main memory and the CPU. The CPU clock as discussed earlier is very fast, whereas the main memory access time is comparatively slower. Hence, no matter how fast the processor is, the processing speed depends more on the speed of the main memory (the strength of a chain is the strength of its weakest link). It is because of this reason that a cache memory, having access time closer to the processor speed, was introduced.

The cache memory stores the program (or its part) currently being executed or which may be executed within a short period of time. The cache memory also stores temporary data that the CPU may frequently require for manipulation.

The cache memory works according to various algorithms, which decide what information it has to store. These algorithms work out the probability to decide which data would be most frequently needed. This probability is worked out on the basis of past observations.

Register

A register is a combination of memory storage locations called flip-flops. Each flip-flop is capable of storing one bit of information. An n-bit register contains ‘n’ flip-flops and is capable of storing ‘n’ bits of information.

Accumulator

The accumulator is a register that is present within the arithmetic logic-unit. The accumulator stores data, which is either the result of an operation, or which is to be processed through arithmetic and logical operations.

Memory Data Register

The memory data register, like the accumulator, is used to store data. This register holds all data and instructions temporarily, as they pass in or out of the main memory.

Memory Address Register

The memory address register contains the address of the memory location (in the main memory) whose data is to be transferred into the memory data register.

In the figure, the Memory Address Register (MAR) contains the address of the third memory location, the data of which is transferred to the Memory Data Register (MDR).

We shall try to explain the functioning of the ALU with the help of an example. Suppose two numbers are to be subtracted. The following steps are involved:

(i) Let the first instruction cause the number 13 to be placed in the accumulator. When the control unit receives this instruction it decodes it and performs the controlling and co-ordination function by sending the number to the accumulator. A special purpose register, that holds the instruction currently being processed by the control unit, is called the Current Instruction Register (CIR).

(ii) The second instruction asks the control unit to send the address of the second number stored in the main memory to the MAR.

(iii) The control unit then causes the contents of that specific address of the main memory to be copied to the MDR.

(iv) Once the numerical data has been passed on to the MDR, the control unit signals the ALU to perform the SUBTRACT Operation which causes the number in the MDR to be subtracted from the number in the accumulator.

AUXILIARY STORAGE MEMORY

The auxiliary storage memory, also known as the secondary memory, is an external (to the CPU) memory. The auxiliary storage devices store system programs, large data files, assemblers, compilers and other programs. In other words, the auxiliary storage devices are used for bulk storage of data. The storage capacity of these devices is unlimited, as an empty device can replace them once the existing device is completely filled. Even the individual storage devices, such as the magnetic tape, have more capacity than the main memory.

The secondary memory is permanent in nature, i.e., the information stored in these devices is not lost unless specifically deleted. Therefore, secondary storage devices can also be used for transportation of data from one computer to another.

These devices are cheaper as compared to the main memory. The information stored in them is first transferred to the main memory and then processed by the CPU. The final result may then be placed in the secondary memory. It is because of this that the access time of the secondary memory is comparatively high. Hence, the data stored in secondary storage devices take more time to process than the data already present in the main memory. In fact, the access time for data stored in the secondary memory is one thousand times that for data stored in the main memory.

Secondary memories may also be considered as input and output devices, as they provide the information as input and store the final results in the output.

Magnetic Tape

The magnetic tape is one of the oldest forms of computer storage. First, and second-generation computers used magnetic tape for most of their storage needs. Today, the magnetic tape is not used as often. The reasons are discussed in this section.

Magnetic tape storage devices work in much the same way that a tape recorder works. Instead of 'play' and 'record', the terms 'read' and 'write' are used. The magnetic tape used by a computer is very much like the tape used on an audio tape recorder. Most mainframe computers use reel-to-reel tapes, minicomputers use cartridges (similar to VCR tapes), and microcomputers use cassettes. Like the tape used in a tape recorder, the computer tape can access what is stored on it only in the order in which the data has been recorded (sequentially). This limited SEQUENTIAL ACCESS, which slows down data access, is such a significant disadvantage that it is used primarily to back up data that is also stored on disk or that will not be needed frequently.

There are some good reasons to use magnetic tape, despite the disadvantages mentioned. Tapes can be recorded, erased and reused many times, and they are inexpensive. Tapes are easily transported from one location to another, and tape drives can store large amounts of data quickly. Magnetic tape capacity is measured in bytes per inch (bpi), known as the tape density. Low-density tapes generally store 1,600 bpi and high-density tapes can store 6,250 bpi. The newest tapes, called R-DATs, can store more than 14 gigabytes on a single 90-metre tape. The speed, the storage capability and the cost of the tape are the reasons why it is still frequently used as a backup medium.

Magnetic Disk

Disk drives can not only store large amounts of data, but also have the capability to directly access a file or records. A MAGNETIC DISK, coupled with a disk drive that can store and retrieve data on the disk, is a RANDOM ACCESS STORAGE MEDIUM; that is, if you need the 189th item, the drive head can go directly to that item and read it. The disk drive’s magnetic head is called a READ/WRITE HEAD.

When you insert a disk into the disk drive, the disk fits on a rod that rotates the disk. The read/write head reads the magnetic impulses. It can move laterally above the surface of the disk, just as you would move a phonograph's arm to locate a specific track on an LP record. A different read/write head is used for each surface of each platter in a disk pack. All the read/write heads are mounted on a single arm, so that each head reads the same track and sector on its platter at the same time. It is important to remember that disk drives are mechanical devices. Problems can occur, so backup copies of important programs and data are essential.

Before a disk can be used for storage, it must be prepared by means of a process called FORMATTING. In this process, the disk drive's read/write head lays down a magnetic pattern on the disk's surface. This pattern enables the basic tasks handled by the computer's operating system.

Data is recorded on a disk in concentric circular bands called tracks. The tracks on a disk are similar to the grooves on a phonograph record. Each track is divided into pie-shaped wedges called sectors. Two or more sectors combine to form a cluster.

Most computers maintain on the disk a table with the sector and track locations of data. This table, called the File Allocation Table (FAT), enables the computer to locate data easily.

There are two popular types of magnetic disks: floppy disks and hard disks. Most of today's personal computers are equipped with both.

Floppy Disk and Disk Drives

A floppy disk is a flexible circle of Mylar plastic. The 3.5-inch version is encased in a hard plastic cover. The 5.25-inch version is encased in a square jacket that is harder than the disk itself but is still flexible. The 3.5-inch disk is a newer design as compared to the 5.25-inch disk, which is rapidly disappearing.

Most personal computers are equipped with one or two disk drives. A disk drive can perform two operations: read and write. A read operation is similar to playing a CD-ROM. The drive "plays" information from the disk and relays it to the processor. A write operation is similar to recording on a cassette tape. The drive records information on the disk. Unlike operating a cassette recorder, though, you don't have to push buttons, these actions occur under the direction of the program you are using. Disks contain a write-protection tab that you can open, to protect data from being over written or deleted.

The density of the magnetic particles on the disk's surface determines the amount of information that can be stored on a floppy disk. Double-density disks store more than the single-density disks of a decade ago. But high-density disks are increasingly common today.

Disks are inexpensive, usually costing less than a dollar each. The storage capacity of floppy disks is relatively limited. In addition, because floppy disks spin only about 300 revolutions per minute, locating data (seek time), waiting for the disk to spin to the correct sector (rotational delay time) are comparatively longer. (The combination of seek time, rotational delay time and transfer time is known as the access time.) For this reason, all new personal computer systems are equipped with hard disks, which have much more storage and operate considerably faster.

Hard Disks

A hard disk is similar to a floppy disk, but the hard disk is made of rigid metallic platters, can hold much more data and operate much faster. Most hard disks are permanently encased in the disk drive, although some drives use removable cartridges. Removable disks, generally known as Bernoulli disks, consist of a single platter encased in a plastic cartridge. Some of the newer removable cartridges, called zip disks, can hold more than 125M on a single 3.5-inch cartridge. A hard disk pack, which is usually found in a desktop computer (or larger), consists of several platters, with data encoded on both sides of each platter. All tracks and sectors in the same relative location on a disk pack form a cylinder. (For example, track 20 sector 2 on platter s1 and track 20 sector 2 on all the other platters in the disk pack form a cylinder.) Many small notebook computers use a hard card, which is a small disk mounted on an expansion card, rather than a full disk drive and pack.

Hard disks spin so rapidly that the read/write head does not touch the surface of the disk. Serious damage can be caused if the read/write head encounters an obstacle, such as dust or a smoke particle, causing the read/write head to bounce on the disk surface.

Performance of hard disks is better than that of floppy disks because:

- A single hard drive may have several platters, providing large data storage capacities.
- Most hard disks are permanently encased within the disk drive in a sealed environment free from dust and dirt. The disk can spin very rapidly, with the read/write head “floating “ above the disk’s surface.
- Hard disks spin at an average of 33,600 revolutions per minute, making data retrieval very fast.

Intense competition and technological innovation are driving hard disk prices down, even as storage capacities rise. Many personal computers have hard disks capable of storing a gigabyte—one billion characters—or more.

Larger computer systems are beginning to use a new type of hard disk storage. A RAID (Redundant Array of Inexpensive Disks) can be composed of more than one hundred 5.25-inch disks with a controller mounted in a single box. RAID storage first appeared on the market in 1993. A RAID can send data simultaneously over multiple data paths quickly.

Hard Disk Interfaces

To connect a hard disk to a microcomputer motherboard, you must have a hard disk interface. This component includes circuitry that conforms to a standard recognized by both the hard disk and the motherboard manufacturer. Common Standards are INTEGRATED DRIVE ELECTRONICS (IDE) and SMALL COMPUTER SYSTEM INTERFACE (SCSI).

Optical Disk

Imagine going into your favourite video store, asking for a movie that you want to see, and being told that you will just have to look around because the employees don't know which movies the store has. If all of our data weren't stored in some logical manner, the scenario might be just like this. To prevent such a situation, we have developed manual filing systems that store records on index cards, in file folders, and on other media. To answer such a query would be equally difficult—even with computers—if we didn't have some organized method for storing all the data. Fortunately, computer storage methods can produce the answer in just a fraction of a minute. In the following explanations , you will learn how a computer stores data and what storage methods are used in data processing applications.

To understand how a computer stores data, you need to know about the storage media that the computers use. You know that the computer translates into binary form all the data and instructions stored internally. You have learned that letters, numbers and special symbols are represented as a group of bits, based on EBCDIC or ASCII coding. Because a computer's memory (RAM) is volatile, you must save data by transferring it from memory to a storage device such as a disk. These storage devices, frequently called SECONDARY STORAGE, are not volatile. They can hold large amounts of data for as long as the user wants. This lesson explains how data is organized when it is saved to a storage device.

Secondary storage is very inexpensive as compared to primary storage (memory). Most computers have a large amount of storage. However, storage devices do not transfer data as quickly as RAM does. When you finish working with an application, you save the results of your work on a secondary storage medium.

CD-ROM works much like the compact discs used in CD players. Just as CDs have revolutionized the music industry, optical disks have the potential to change secondary storage media. Based on the same laser technology as CDs, optical disks offer a medium capable of storing extremely large amounts of data. The three main types of optical disks are CD-ROM, WORM CD, and MO technology.

The most popular and least expensive type of optical disk is Compact Disk Read–Only Memory (CD-ROM). As the name indicates, these disks come prerecorded and cannot be altered; CD-ROM is, in other words, a read-only storage medium. Still, CD-ROM provides an excellent way to distribute large amounts of data at low cost. CDs can store up to 650MB of data, yet they can cost as little as a dollar per disk.

To use a CD-ROM, you must have a computer equipped with a CD-ROM drive. Double-speed drives achieve the minimum level of retrieval speed for multimedia applications. (A double–speed drive is slower than a floppy drive). Eight–speed drives are decreasing in cost and becoming common in new computer systems, and Ten-speed drives are available at a higher price. CD-ROM towers, containing as many as 256 CD-ROM drives, are frequently attached to CD servers so that all the computers on a network can share what is stored on the CD-ROMs.

The CD-ROM has been used primarily to market large applications. For example, Infopedia is a single CD that holds a complete encyclopedia, a dictionary, a thesaurus, a world atlas, a dictionary of quotations, a world almanac and a biographical dictionary. The Total Baseball CD holds statistics of over 13,000 players, with photographs of their trading cards, and explanatory sound clips. You can tour the National Art Gallery on CD-ROM or play a variety of games.

A WRITE ONCE, READ MANY COMPACT DISCS (WORM CD) is purchased blank from the manufacturer and encoded using special equipment. The disks can't be altered after they are encoded and can't be easily duplicated because the encoding process does not actually pit the disk. Many businesses use WORM CDs to store old data files. This practice, known as archiving, enables old files to be deleted from the hard disk, thus freeing space for new files. WORM CDs are used most frequently for document processing with complete image processing, including replication of photos, graphics, text and even signatures.

Until recently, recording on a CD-ROM required separate, very expensive equipment. Now drives that can write to and read a CD, called CD-Recordable (CD-R) drives, are available for less than $900, and the prices are reducing further rapidly. A blank disk costs about $15. CD-R is a WORM process. Any standard CD-ROM unit can read the disks.

If you want to create a multimedia presentation and then play it back on any available computer equipped with a CD-ROM drive, CD-R is the tool you are looking for. With the large capacity of a CD-R (roughly 600 megabytes per disk), you can create and store an entire multimedia presentation on a single disk. (Floppy disks don't have this capacity).

CD-Rs look like standard CD-ROMs except that they are golden in colour, rather than the silver of "mastered" CD-ROMs. The blank disks are made with the spiral tracks impressed on the recording surface. Because CD-ROMs are read by refraction of light, a dye layer is discoloured in the recording process, which causes the area either to reflect light or to disperse it.

The technology to make CD-Erasable (CD-E) disks became recently available. CD-E enables users to store, access and reuse disks in the same way that floppy disks can be used. Because of the large storage capacity of CDs, they will in all likelihood make magnetic tapes, and perhaps floppy disks as well, a thing of the past.

MAGNETO-OPTICAL (MO) disks are erasable, and combine the magnetic principles used on tape and disk with new optical technology. MO disks measure storage capacity in gigabytes; they are removable, portable and durable. One of the newest MO systems—Orray produced by Pinnacle Micro—uses a storage method similar to that of RAID. Optical disks have a thirty-year shelf life and are ideal for graphics and audio-visual applications that require large storage capacity.

Flash Memory

Flash memory (sometimes called "flash RAM") is a type of constantly powered nonvolatile memory which means that it stores information on a silicon chip in a way that does not need power to maintain the information in the chip. It can be erased and reprogrammed in units of memory called blocks. It is a variation of Electrically Erasable Programmable Read-Only Memory (EEPROM), which, unlike flash memory, is erased and rewritten at the byte level, which is slower than flash memory updating. Normal EEPROM only allows one location at a time to be erased or written, meaning that flash memory can operate at effectively higher speeds when the system uses it to read and write to different locations at the same time. Flash memory is often used to hold control code such as the Basic Input/Output System (BIOS) in a personal computer. When BIOS needs to be changed (rewritten), the flash memory can be written to in block (rather than byte) sizes, making it easy to update. On the other hand, flash memory is not as useful as Random Access Memory (RAM) because RAM needs to be addressable at the byte (not the block) level.

Flash memory offers fast read access times and solid-state shock resistance. These characteristics explain the popularity of flash memory for applications such as storage on battery-powered devices like cellular phones and PDAs.

Flash memory is based on the Floating-Gate Avalanche-Injection Metal Oxide Semiconductor (FAMOS transistor), which is essentially an NMOS transistor with an additional conductor suspended between the gate and source/drain terminals.

Flash memory is made in two forms: NOR flash and NAND flash. The names refer to the type of logic gate used in each storage cell. Flash memory is often used in MP3 players, digital cameras and mobile phones.

Principles of Operation

Flash memory stores information in an array of transistors, called "cells," each of which traditionally stores one bit of information. Newer flash memory devices, sometimes referred to as multi-level cell devices, can store more than 1 bit per cell, by varying the number of electrons placed on the FG of a cell.

In NOR flash, each cell looks similar to a standard MOSFET transistor, except that it has two gates instead of just one. One gate is the Control Gate (CG) like in other MOS transistors, but the second is a Floating Gate (FG) that is insulated all around by an oxide layer. The FG is between the CG and the substrate. Because the FG is isolated by its insulating oxide layer, any electrons placed on it get trapped there and thus store the information. When electrons are on the FG, they modify (partially cancel out) the electric field coming from the CG, which modifies the threshold Voltage (Vt) of the cell. Thus, when the cell is "read" by placing a specific voltage on the CG, electrical current will either flow or not flow, depending on the Vt of the cell, which is controlled by the number of electrons on the FG. This presence or absence of current is sensed and translated into 1's and 0's, reproducing the stored data. In a multi-level cell device, which stores more than 1 bit of information per cell, the amount of current flow will be sensed, rather than simply the presence or absence of current, in order to determine the number of electrons stored on the FG.

A NOR flash cell is programmed (set to a specified data value) by starting up electrons flowing from the source to the drain. Then a large voltage placed on the CG provides a strong enough electric field to suck them up onto the FG, a process called hot-electron injection. To erase a NOR flash cell (reset to all 1's, in preparation for reprogramming), a large voltage differential is placed between the CG and source, which pulls the electrons off through Fowler-Nordheim tunneling, a quantum mechanical tunneling process. Most modern NOR flash memory components are divided into erase segments, usually called either blocks or sectors. All of the memory cells in a block must be erased at the same time. NOR programming, however, can generally be performed one byte or word at a time.

NAND Flash uses tunnel injection for writing and tunnel release for erasing. NAND flash memory forms the core of the removable USB interface storage devices known as keydrives.

NOR flash was the first type to be developed, invented by Intel in 1988. It has long erase and write times, but has a full address/data (memory) interface that allows random access to any location. This makes it suitable for storage of a program code that needs to be infrequently updated, such as a computer's BIOS or the firmware of set-top boxes. Its endurance is 10,000 to 1,000,000 erase cycles. NOR-based flash is the basis of early flash-based removable media; Compact Flash was originally based on it, though the later cards moved to the cheaper NAND flash.

NAND flash from Samsung and Toshiba followed in 1989. It has faster erase and write times, a higher density, and a lower cost per bit than NOR flash, and ten times the endurance. However its I/O interface allows only sequential access to data. This makes it suitable for mass-storage devices such as PC cards and various memory cards, and somewhat less useful for computer memory. The first NAND-based removable media format was SmartMedia, and numerous others have followed: MMC, Secure Digital, Memory Stick and xD-Picture Cards.

One limitation of flash memory is that while it can be read or programmed a byte or a word at a time in a random access fashion, it must be erased a "block" at a time. Starting with a freshly erased block, any byte within that block can be programmed. However, once a byte has been programmed, it cannot be changed again until the entire block is erased. In other words, flash memory (specifically NOR flash) offers random-access read and programming operations, but cannot offer random-access rewrite or erase operations. When compared to a hard disk drive, a further limitation is the fact that flash memory has a finite number of erase-write cycles, so that care has to be taken when moving hard-drive based applications, such as operating systems, to flash-memory based devices such as CompactFlash.

Interestingly, the Tungsten T5 PDA and the Treo 650 smartphone from PalmOne, released in late 2004, use NAND flash to back up the contents of main memory during normal operations. PalmOne names this technique "non-volatile file system" (NVFS). It gives the illusion of a RAM storage pool that does not lose any of its data when power is removed. This PalmOne knowledge-based article explains how this technique works on the Treo 650.

The cost per byte of flash memory remains significantly higher than the corresponding cost of a hard disk drive, and that has prevented flash from becoming a solid state replacement for the hard disk drive on most home and office computers.

Because of the particular characteristics of flash memory, it is best utilized with specifically designed file systems which spread-write over the media and deal with the long erase times of NOR flash blocks. The basic concept behind flash file systems is: when the flash store is to be updated, the file system will write a new copy of the changed data over to a fresh block, remap the file pointers, then erase the old block later when it has time.

JFFS was the first of these file systems, quickly superseded by JFFS2, originally developed for NOR flash. Then YAFFS was released in 2003, dealing specifically with NAND flash, and JFFS2 was updated to support NAND flash too. However, in practice most flash media is used with the old FAT filesystem for compatibility purposes.

A special issue is flash memory booting.

Common flash memory parts range widely in capacity from kilobits to hundreds of megabits each. Parts can be combined to provide even larger capacities within a package.

Toshiba and SanDisk have developed a NAND flash part capable of storing 8 gigabits of data.

Here are a few examples of Flash memory:

- Computer's BIOS chip
- CompactFlash (most often found in digital cameras)
- SmartMedia (most often found in digital cameras)
- Memory Stick (most often found in digital cameras)
- PCMCIA Type I and Type II memory cards (used as solid-state disks in laptops)
- Memory cards for video game consoles

REVISION EXERCISES

Fill in the blanks

1. Secondary storage can be organized into .... that contain ....
2. Magnetic tape can store only .... files.
3. An optical device that has both read and write capabilities is called ....
4. Before a disk can be used for storage, it should first be ....
5. The amount of information that can be stored on a floppy disk is determined by .... of the ....on the surface of the disk.
6. ......-density disks can store more than the .....-density disks.
7. Data is recorded on a disk in concentric circular bands called ....
8. The table that enables the computer to locate data easily is called ....
9. Each track is subdivided into .... and two or more .... combine together to form a ....
10. Removable disks are also called ....

Answers

1. Directories, files 2. Sequential files

3. CD-ROM 4. Formatted

5. Density, magnetic particles

6. Double, single 7. Tracks

8. File allocation table(FAT)
9. Sectors, sectors, cluster
10. Bernoulli Disks

REVIEW QUESTIONS

1. List all types of secondary storage devices.
2. Compare all types of storage devices and explain why CD ROMs are grabbing the market fast.
3. Write down the evolution of floppy disks from the beginning till now.
4. How is a removable hard disk better than the hard disk and the floppy disk?
5. What is the term used to measure the capacity of the disks?
6. How is the read and write head able to pass the data to and from the surface of the disk?
7. Write a note on SCSI.
8. Jot down some of the advantages and disadvantages of CD-ROMs over the floppy diskettes.
9. Explain Read Only Memory. How is it different from the main memory?
10. What is RAM and EEPRAM?
11. Will adding more RAM make Internet browsing faster?
12. What is the difference between RDRAM AND SDRAM?
13. This is a general term for all forms of solid state memory that have a continuous source of power and do not need to have their memory contents periodically refreshed.
    a. flash memory
    b. random access memory
    c. volatile memory
    d. nonvolatile memory

Chapter 5: PROCESSOR

INTRODUCTION

Someone who processes things is a processor. It is the part of a computer (a microprocessor chip) that does most of the data processing; the CPU and the memory form the central part of a computer to which the peripherals are attached.

The processor sub-system of a data processing system processes received information after it has been encoded into data by the input sub-system. These data are then processed by the processing sub-system before being sent to the output sub-system where they are decoded back into information.

The two major types of digital processors are the Central Processing Unit (CPU) and the Digital Signal Processor (DSP). There are two main types of processors: CISC and RISC

CENTRAL PROCESSING UNIT

The part of a computer (a microprocessor chip) that does most of the data processing, the CPU and the memory form the central part of a computer to which the peripherals are attached. The Central Processing Unit (CPU) is the part of a computer that interprets and carries out the instructions contained in the software.

DIGITAL SIGNAL PROCESSOR (DSP)

A digital signal processor is a specialized microprocessor designed specifically for digital signal processing, generally in real-time. DSPs can also be used to perform general-purpose computation, but they are not optimized for this function. DSPs can also be purely software, and are usually used to re-encode audio for Internet radio stations in real-time.

INTERRUPT STRUCTURE

A signal informing a program that an event has occurred is an interrupt. When a program receives an interrupt signal, it takes a specified action. Interrupt signals can cause a program to suspend itself temporarily to service the interrupt.

Interrupt signals can come from a variety of sources. For example, every keystroke generates an interrupt signal. Interrupts can also be generated by other devices, such as a printer, to indicate that some event has occurred. These are called hardware interrupts. Interrupt signals initiated by programs are called software interrupts. A software interrupt is also called a trap or an exception.

PCs support 256 types of software interrupts and 15 hardware interrupts. Each type of software interrupt is associated with an interrupt handler — a routine that takes control when the interrupt occurs. For example, when you press a key on your keyboard, this triggers a specific interrupt handler. The complete list of interrupts and associated interrupt handlers is stored in a table called the interrupt vector table, which resides in the first 1 K of addressable memory.

The processor is a highly-tuned machine that is designed to do one thing at a time. However, we use our computers in a way that requires the processor to at least appear to do many things at once. In Windows 95, you may have been editing a document while downloading information on your modem and listening to a CD simultaneously. The processor is able to do this by sharing its time among the various programs it is running and the different devices that need its attention. It only appears that the processor is doing many things at once because of the blindingly high speed that it is able to switch between tasks.

Most of the different parts of the PC need to send information to and from the processor, and they expect to be able to get the processor's attention when they need to do this. The processor has to balance the information transfers it gets from various parts of the machine and make sure that they are handled in an organized manner. There are two basic ways that the processor can do this:

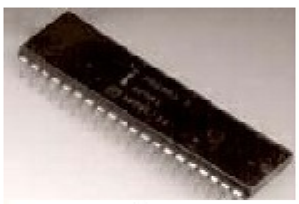
- Polling: The processor can take turns going to each device and asking if they have anything they need it to do. This is called polling the devices. In some situations this technique is used; however, it is not used by the processor in a PC for a couple of basic reasons. One reason is that it is wasteful; going around to all the devices constantly asking if they need the attention of the CPU wastes cycles in which the processor could be doing something useful. This is particularly true because in most cases the answer will be "no". Another reason is that different devices need the processor's attention at differing rates; the mouse needs attention far less frequently than say, the hard disk, when it is actively transferring data.
- Interrupting: The other way that the processor can handle information transfers is to let the devices request them when they need its attention. This is the basis for the use of interrupts. When a device has data to transfer, it generates an interrupt that says "I need your attention now, please". The processor then stops what it is doing and deals with the device that requested its attention. It actually can handle many such requests at a time, using a priority level for each to decide which to handle

first.

MICROPROCESSOR HISTORY

Intel 4004 chip

A microprocessor, also known as a CPU or central processing unit, is a complete computation engine that is fabricated on a single chip. The first microprocessor was the Intel 4004, introduced in 1971. The 4004 was not very powerful. All it could do was add and subtract, and it could only do that 4 bits at a time. But it was amazing that everything was on one chip. Prior to the 4004, engineers built computers either from collections of chips or from discrete components (transistors wired one at a time). The 4004 powered one of the first portable electronic calculators.



Intel 8080

The first microprocessor to make it into a home computer was the Intel 8080, a complete 8-bit computer on one chip, introduced in 1974. The first microprocessor to make a real splash in the market was the Intel 8088, introduced in 1979 and incorporated into the IBM PC (which first appeared around 1982). If you are familiar with the PC market and its history, you know that the PC market moved from the 8088 to the 80286 to the 80386, to the 80486, to the Pentium I, to the Pentium II, to the Pentium III, and hence to the Pentium 4. Intel makes all of these microprocessors, and all of them are improvements on the basic design of the 8088. The Pentium 4 can execute any piece of code that ran on the original 8088, but it does it about 5,000 times faster

PROCESSOR INSTRUCTION SETS

The job of all processors is to execute instructions, which are the commands that make up the machine language that the processor understands. Most software programs are written in higher-level languages, but they must be translated into the processor's machine language to enable the computer to run (execute) them. This is called compiling the program to machine language.

Collectively, all of the various instructions that the processor can execute are called its instruction set. The instruction set determines what sort of software can run on the processor; in order for two processors to be compatible, they must (among other things) be able to execute the same instructions.

Machine Language

Computers represent instruction sets in a particular way, and this representation is what we call machine language.

Machine language is a coding scheme which instructs the computer as to what to do. In the same way as we used different notations for representing numbers (2's complement, excess notation), we need a coding scheme which will allow us to represent each of our items in the instruction set in binary. We can't just tell the machine "add together 2 and 4". It doesn't understand our words. It also needs to be told where to fetch data from memory and where exactly to store the result. The machine uses strings of 1's and 0's.

A typical machine language represents a certain instruction by way of a special code. These special codes used for representing instructions comprise of different sections (called fields), which describe different aspects of the instruction:

1. The first part of an instruction code is called the operation code (op-code for short). This indicates which operation is to be performed (e.g. addition, retrieval of a data item from memory etc.)
2. The second part is called the operand field. This part of the code fills in the details which are needed before the operation specified in (1) can be performed. For example, if the op-code field specifies addition, the operand fields will tell the machine which memory addresses hold the pieces of data which are to be summed.

So what do these op-code and operand fields look like? Well, they are simply bit patterns - strings of 0's and 1's. (Remember - the computer only understands binary).

So a computer may well store an instruction as:

Operation Code	Address Field 1	Address Field 2	Address Field 3

A Typical Machine Language Coding For An Instruction

The operations which we represent in the op-code fall into three categories.

1. Data transfer
2. Arithmetic/Logic
3. Control (sometimes divided into two separate categories of compare and branch)

The Data Transfer group concern operations, which cause some movement of data from one location to another. This could be loading the contents of a memory cell in RAM into a register on the CPU; or it could be storing the results of an operation from a CPU register back into a RAM memory cell.

The Arithmetic/Logic operations involve the usual mathematical type of operation such as addition, but also includes logical operations such as "is X greater than Y?" or "is A equal to B?" The condition codes are special registers which are used for storing the results of these logical operations and can be set to "1" if the result of the logical operation is true, or “0” if the result is false.

The Control Operations are those, which somehow affect the execution of a program. Usually, this means that a logical operation is performed, and then, depending upon the results of that operation, the program execution follows one “path” or another. In other words, if $X > Y$ then execute this set of instructions, otherwise execute this other group of instructions (The “jump” and “halt” instructions).

Instruction Set

It is a set of commands that a certain CPU understands. These are very basic instructions that are used into the logic of the CPU.

Assembly Language Instruction	Example	Meaning	Machine Language Instruction
NOP HALT	NOP HALT	Do nothing. Halt the machine.	0000 0000 0000 0000 1111 1111 1111 1111
LOAD [REG] [MEM] STORE [MEM] [REG]	LOAD R2 13 STORE 8 R3	R2 = M[13] M[8] = R3	1 000 000 1 0 RR MMMMM 1 000 0010 0 RR MMMMM
ADD [REG1] [REG2] [REG3]	ADD R3 R2 R1	R3 = R2 + R1	1 010 0001 00 RR RR RR

PROCESSOR STRUCTURE

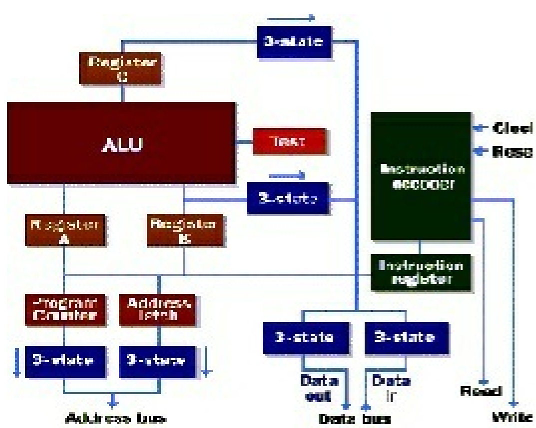
Before we look at basic processor structure, we need to briefly touch on two concepts: von Neumann machines and pipelined, clocked logic systems.

von Neumann Machines

In the early 1950s, John von Neumann proposed the concept of a stored program computer - an architecture which has become the foundation for most commercial processors used today. In a von Neumann machine, the program and the data occupy the same memory. The machine has a Program Counter (PC) which points to the current instruction in memory. The PC is updated on every instruction. When there are no branches, program instructions are fetched from sequential memory locations. (A branch simply updates the PC to some other location in the program memory.) Except for a handful of research machines and a very small collection of commercial devices, all of today's commercial processors work on this simple principle.

Basic Processor Structure

Here we will consider the basic structure of a simple processor. We will examine the flow of data through such a simple processor and identify bottlenecks in order to understand what has guided the design of more complex processors.



Here we see a very simple processor structure - such as might be found in a small

8-bit microprocessor. The various components are:

Arithmetic Logic Unit (ALU)

Arithmetic Logic Unit - this circuit takes two operands on the inputs (labelled A and B) and produces a result on the output (labelled Y). The operations will usually include, at a minimum:

- Add, subtract
- And, or, not
- Shift right, shift left

ALUs in more complex processors will execute many more instructions.

Register File

A set of storage locations (registers) for storing temporary results. Early machines had just one register - usually termed an accumulator. Modern RISC processors will have at least 32 registers.

Instruction Register

The instruction currently being executed by the processor is stored here.

Control Unit

The control unit decodes the instruction in the instruction register and sets signals which control the operation of most other units of the processor. For example, the operation code (op-code) in the instruction will be used to determine the settings of control signals for the ALU, which determine which operation (+, -, ^, v, ~, shift, etc) it performs.

Clock

The vast majority of processors are synchronous, that is, they use a clock signal to determine when to capture the next data word and perform an operation on it. In a globally synchronous processor, a common clock needs to be routed (connected) to every unit in the processor.

Program Counter

The program counter holds the memory address of the next instruction to be executed. It is updated every instruction cycle so as to point to the next instruction in the program. (Control for the management of branch instructions - which change the program counter by other than a simple increment - has been omitted from this diagram for clarity.

Branching instructions and their effect on program execution and efficiency will be examined extensively later).

Memory Address Register

This register is loaded with the address of the next data word to be fetched from or stored into main memory.

Address Bus

This bus is used to transfer addresses to memory and memory-mapped peripherals. It is driven by the processor acting as a bus master.

Data Bus

This bus carries data to and from the processor, memory and peripherals. It will be driven by the source of data, ie the processor, memory or peripheral device.

Multiplexed Bus

Of necessity, high performance processors provide separate address and data buses. To limit device pin counts and bus complexity, some simple processors multiplex address and data onto the same bus: naturally this has an adverse affect on performance.

EXECUTING INSTRUCTIONS

Let's examine the steps in the execution of a simple memory fetch instruction, eg

$101c_{16}$: lw \$1,0(\$2) This instruction tells the processor to take the address stored in register 2, add 0 to it and load the word found at that address in main memory into register 1.	In this, and most following, examples, we'll use the MIPS instruction set. This is chosen because • it's simple, • it exists in one widely available range of machines produced by SGI and • there is a public domain simulator for MIPS machines, which we will use for some performance studies.
As the next instruction to be executed (our lw instruction) is at memory address $101c_{16}$, the program counter contains 101c.	For convenience, most numbers - especially memory addresses and instruction contents - will be expressed in hexadecimal. When orders of magnitude and performance are being discussed, decimal numbers will be used: this will generally be obvious from the context and the use of exponent notations, *eg* 5×10^{12}.

Execution Steps

1. The control unit sets the multiplexor to drive the PC onto the address bus.
2. The memory unit responds by placing $8c410000_{16}$ - the lw $1,0($2) instruction as encoded for an MIPS processor - on the data bus from where it is latched into the instruction register.
3. The control unit decodes the instruction, recognises it as a memory load instruction, and directs the register file to drive the contents of register 2 onto the A input of the ALU and the value 0 onto the B input. At the same time, it instructs the ALU to add its inputs.
4. The output from the ALU is latched into the MAR. The controller ensures that this value is directed onto the address bus by setting the multiplexor.
5. When the memory responds with the value sought, it is captured on the internal data bus and latched into register 1 of the register file.
6. The program counter is now updated to point to the next instruction and the cycle can start again.

As another example, let's assume the next instruction is an add instruction:

1020_{16}: add $1,$3,$4	This instruction tells the processor to add the contents of registers 3 and 4 and place the result in register 1.

1. The control unit sets the multiplexor to drive the PC onto the address bus.
2. The memory unit responds by placing 00232020_{16} - the encoded add $1,$3,$4 instruction - on the data bus from where it is latched into the instruction register.
3. The control unit decodes the instruction, recognises it as an arithmetic instruction and directs the register file to drive the contents of register 1 onto the A input of the ALU and the contents of register 3 onto the B input. At the same time, it instructs the ALU to add its inputs.
4. The output from the ALU is latched into the register file at register address 4.
5. The program counter is now updated to point to the next instruction.

MULTIPROGRAMMING

Multiprogramming is a rudimentary form of parallel processing in which several programs are run at the same time on a single processor. Since there is only one processor, there can be no true simultaneous execution of different programs. Instead, the operating system executes part of one program, then part of another, and so on. To the user it appears that all programs are being executed at the same time.

If the machine has the capability of causing an interrupt after a specified time interval, then the operating system will execute each program for a given length of time, regain control, and then execute another program for a given length of time, and so on. In the absence of this mechanism, the operating system has no choice but to begin to execute a program with the expectation, but not the certainty, that the program will eventually return control to the operating system.

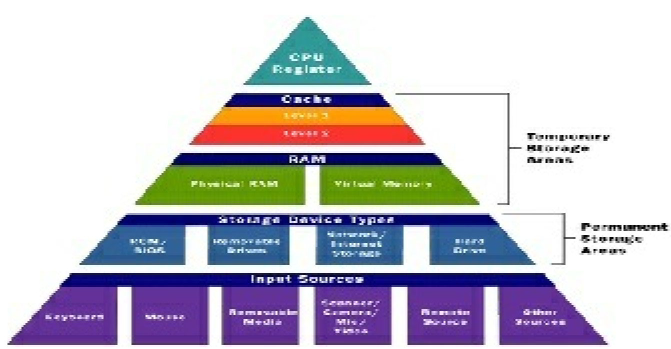
If the machine has the capability of protecting memory, then a bug in one program is less likely to interfere with the execution of other programs. In a system without memory protection, one program can change the contents of storage assigned to other programs or even the storage assigned to the operating system. The resulting system crashes are not only disruptive, they may be very difficult to debug since it may not be obvious which of several programs is at fault.

Virtual Memory

Virtual memory is a common part of most operating systems on desktop computers. It has become so common because it provides a big benefit to users at a very low cost.

Most computers today have something like 32 or 64 megabytes of RAM available for the CPU to use. Unfortunately, that amount of RAM is not enough to run all of the programs that most users expect to run at once.

For example, if you load the operating system, an e-mail program, a Web browser and a word processor into RAM simultaneously, 32 megabytes is not enough to hold it all. If there were no such thing as virtual memory, then once you filled up the available RAM your computer would have to say, “Sorry, you can not load any more applications. Please close another application to load a new one.” With virtual memory, what the computer can do is look at RAM for areas that have not been used recently and copy them onto the hard disk. This frees up space in RAM to load the new application.



Because this copying happens automatically, you don’t even know it is happening, and it makes your computer seem like is has unlimited RAM space even though it only has 32 megabytes installed. Because hard disk space is so much cheaper than RAM chips, it also has a nice economic benefit.

Speed Concerns

The read/write speed of a hard drive is much slower than that of RAM, and the technology of a hard drive is not geared toward accessing small pieces of data at a time. If your system has to rely too heavily on virtual memory, you will notice a significant performance drop. The key is to have enough RAM to handle everything you tend to work on simultaneously — then, the only time you “feel” the slowness of virtual memory is when there’s a slight pause when you’re changing tasks. When that’s the case, virtual memory is perfect. When this is not the case, the operating system has to constantly swap information back and forth between RAM and the hard disk. This is called thrashing, and it can make your computer feel incredibly slow.

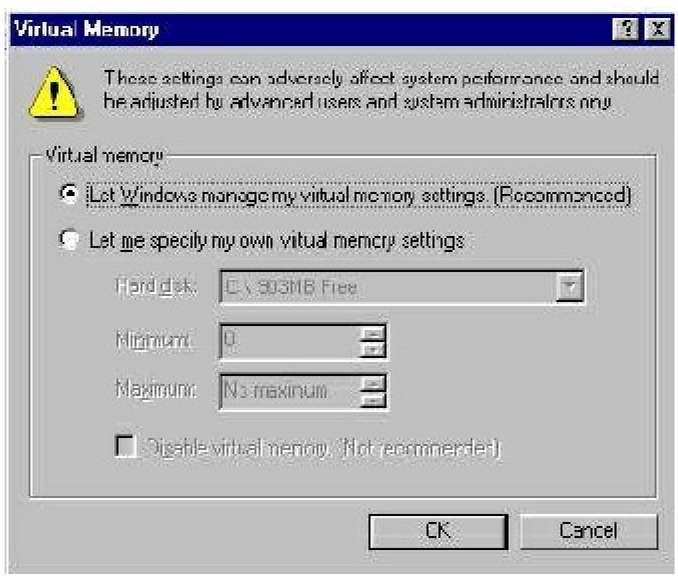
The area of the hard disk that stores the RAM image is called a page file. It holds pages of RAM on the hard disk, and the operating system moves data back and forth between the page file and RAM. On a Windows machine, page files have a .SWP extension

Configuring Virtual Memory

Take Windows 98 as an example of a typical operating system that has virtual memory. Windows 98 has an intelligent virtual memory manager that uses a default setting to help Windows allocate hard drive space for virtual memory as needed. For most circumstances, this should meet your needs. But you may want to manually configure virtual memory, especially if you have more than one physical hard drive or speed-critical applications.

To do this, open the “Control Panel” window and double-click on the “System” icon. The system dialog window will open. Click on the “Performance” tab and then click on the “Virtual Memory” button.

Click on the option that says, “Let me specify my own virtual memory settings.” This will make the options below that statement become active. Click on the drop-down list beside “Hard disk:” to select the hard drive that you wish to configure virtual memory for. Remember that a good rule of thumb is to equally split virtual memory between the physical hard disks you have.



In the “Minimum:” box, enter the smallest amount of hard drive space you wish to use for virtual memory on the hard disk specified. The amounts are in megabytes. For the “C:” drive, the minimum should be 2 megabytes. The “Maximum:” figure can be anything you like, but one possible upper limit is twice the physical RAM space. Windows default is normally 12 megabytes above the amount of physical RAM in your computer. To put the new settings into effect, close the dialog box and restart your computer.

Memory Allocation

The amount of hard drive space you allocate for virtual memory is important. If you allocate too little, you will get "Out of Memory" errors. If you find that you need to keep increasing the size of the virtual memory, you probably are also finding that your system is sluggish and accesses the hard drive constantly. In that case, you should consider buying more RAM to keep the ratio between RAM and virtual memory about 2:1. Some applications enjoy having lots of virtual memory space but do not access it very much. In that case, large paging files work well.

One trick that can improve the performance of virtual memory (especially when large amounts of virtual memory are needed) is to make the minimum and maximum sizes of the virtual memory file identical. This forces the operating system to allocate the entire paging file when you start the machine. That keeps the paging file from having to grow while programs are running, which improves performance. Many video applications recommend this technique to avoid pauses while reading or writing video information between hard disk and tape.

Another factor in the performance of virtual memory is the location of the page file. If your system has multiple physical hard drives (not multiple drive letters, but actual drives), you can spread the work among them by making smaller page files on each drive. This simple modification will significantly speed up any system that makes heavy use of virtual memory.

REVISION EXERCISES

1. Virtual memory provides:
   a. Automatic storage allocation
   b. Protection
   c. Shareability
   d. All the above
2. On a 32-bit machine, what is the maximum size of the virtual address space?
   a. 4 Megabytes
   b. 2 Kilobytes
   c. 4 Gigabytes
   d. All the above
3. What is the significance of interrupts?
4. Write a machine language program to add 3 numbers and output the required answer.

5. What is the main task of a processor? How does it manage the mathematical computations?

6. The Control Unit

   a. Performs the arithmetic operations

   b. Manages and co-ordinates the entire computer system

   c. Executes the logic operations

   d. Performs the actual processing on the data

7. What are the advantages and disadvantages of developing a software package using a high-level language, an assembly language and machine language?

Answers

1.	d	2.	c

Chapter 6: BINARY ARITHMETIC

INTRODUCTION

All the arithmetic operations (addition, subtraction, multiplication and division etc.) in binary system are performed in the same way as in decimal number system. The four arithmetic operations are described as below.

BINARY ADDITION

Rules for carrying out binary additions are:

0 + 0 = 0

0 + 1 = 1

1 + 0 = 1

1 + 1 = 0 with one 1 carry over.

Here are a few examples.

1. Add $(101110)_2$ and $(111101)_2$

Binary	*Decimal*
101110	46
111101	61
1101011	107

One can verify that $(1101011)_2$ in binary system is equivalent to 107 in the decimal system.

2. Add 100000_2 and 1011_2

Binary	*Decimal*
100000	32
1011	11
101011	43

The binary equivalent of 43 in the decimal system is 101011.

3. Add 101110 and 111101

Binary	Decimal
101110	46
111101	61
1101011	107

BINARY SUBTRACTION

Rules for carrying out binary subtractions are:

1. 0 - 0 = 0
2. 0 - 1 = 1 with one borrow
3. 1 - 0 = 1
4. 1 - 1 = 0

Here are a few examples.

1. Subtracting 101110_2 from 111101_2

Binary	Decimal
111101	61
101110	46
001111	15

Thus 001111 in binary system is equivalent to 15 in the decimal system.

2. Subtracting 1011 from 100000

Binary	Decimal
100000	32
1011	11
010101	21

The binary equivalent of 21 in the decimal system is 10101.

3. Subtracting 11 from 1001

Binary	Decimal
1001	9
11	3
0110	6

SIGNED NUMBERS

To represent signed numbers as sequences of bits, the place-value notation used for unsigned numbers must be extended to indicate whether a number is positive or negative. There are two schemes for doing this – sign – magnitude representations and 2's complement notation.

Sign-magnitude Representation

In sign-magnitude representations, the sign bit (also known as the high bit) of a binary number indicates whether the number is positive or negative, and the remainder of the number indicates the absolute value (or magnitude) of the number, using the same format as unsigned binary representation. N-bit sign-magnitude numbers can represent quantities from $-(2^{(N-1)} - 1)$ to $+(2^{(N-1)} - 1)$. There are two representations of 0 in sign-magnitude notation: +0 and –0. +0 has a value of 0 in the magnitude field and a positive sign bit. –0 has a value of 0 in the magnitude field and a negative sign bit.

Consider the following example.

The 16-bit unsigned binary representation of 168 is 0000 0000 1010 1000. In a 16-bit sign-magnitude system, -168 would be represented as 1000 0000 1010 1000. Here, the left most bit of the number is the sign bit and the rest of the number gives the magnitude.

Sign-magnitude representations have the advantage that the negative of a number can very easily be taken by simply inverting the sign bit. Determining whether a number is positive or negative is also easy, as it only requires examining the sign bit. Sign-magnitude representation makes it easy to perform multiplication and division on signed numbers, but hard to perform addition and subtraction. For multiplication and division, the hardware can simply perform unsigned operations on the magnitude portion of the inputs and examine the sign bits of the inputs to determine the sign bit of the result.

Consider the following example of multiplying the numbers +6 and –8, using 6-bit sign-magnitude integers.

Binary representation of +6 = 000110

Binary representation of -8 = 101000

To multiply these numbers, their magnitude portions are multiplied as unsigned integers, giving 0110000(48). Then the sign bits of the numbers are examined, multiplied and thereby determined that one of them is negative. Therefore, the result of the multiplication must be negative, giving 1110000(-48).

Addition and subtraction of sign-magnitude numbers require relatively complex hardware, because adding (or subtracting) the binary representation of a positive number and the binary representation of a negative number does not give the correct result. The hardware must take the value of the sign bit into account when computing each bit of the output, and different hardware is required to perform addition and subtraction. This hardware complexity is the reason why very few current systems use sign-magnitude notation for integers.

Consider the following example of addition of +7 and –2 using 8-bit sign-magnitude representation.

8-bit sign-magnitude representations of +7 = 00000111

8-bit sign-magnitude representations of -2 = 10000010

Addition = 10001001

Adding these numbers, sign-magnitude systems interpret it as –17 instead of 5 (which is the correct result).

2's Complement Notation

In 2's complement notation, a negative number is represented by inverting each bit of the unsigned representation of the number and adding 1 to the result, discarding any overflow bits that do not fit in the width of the representation. The name two's complement comes from the fact that the unsigned sum of an n-bit 2's complement number and its negative is 2^n.

Hence, 2's complement can be formed by leaving all least significant 0's and the first 1 unchanged and then replacing 1's by 0's and 0's by 1's in all other higher significant bits. The 2's complement of 1001100 is 0110100.

Example

What is the 8-bit 2's complement representation of –7 and what is the unsigned result of adding the representations of +7 and –7?

Solution

8-bit sign-magnitude representation of +7 = 00000111

Hence,

8-bit negation of each bit of +7 = 11111000
(known as 1's complement)

Adding 1 + 1
11111001

Thus, the 2's complement representation of +7 is 11111001.

Now adding +7 and –7

00000111 + 11111001 = 100000000 = 0 with 1 overflow bit.

Example

Add +5 and –4 with the help of 2’s complement.

Solution

4-bit binary notation of +5 = 0101

4-bit binary notation of -4 = 1100

2’s complement notation of +5 = 1011

2’s complement notation of -4 = 0100

Addition 1111

1111 is 2’s complement notation of –1.

Example

Compute –5 –4 in 4 bit 2’s-complement notation.

Solution

-5 –4 = -5 + (-4).

2’s complement notation of -5 = 0011

2’s complement notation of -4 = 0100

Addition 0111

0111 is 2’s complement notation of –9.

BINARY MULTIPLICATION

The rules for this multiplication are:

0 x 0 = 0

0 x 1 = 0

1 x 1 = 1

Here are a few examples:

Multiply 111101 by 1110

Binary	Decimal
111101	61
x 1110	x 14
000000	244
111101x	61x
111101xx	
111101xxx	854
1101010110	

Multiply 110 by 010

Binary

```
      110
x     010
---------
      000
     110x
    000xx
---------
    01100
---------
```

BINARY DIVISION

The rules for division are same in the binary system as those in the decimal number system.

Example

Divide 100100 by 110

Solution

```
110 | 100100 | 0110
       110
      -----
       0110
        110
      -----
          x
```

This is the same as the division of the decimal number 36 by 6. Here, the quotient is 0110 and the remainder is 000.

Example

Divide 110111 by 1011

Solution

```
1011 | 110111 | 101
       1011
       ----
        1011
        1011
       ----
         X
       ----
```

The quotient is 101 and the remainder is 000.

REVISION EXERCISES

i. Add the following binary numbers:

a. 101 & 110

b. 1001.1 & 1100.1

c. 110.1101 & 100.1010

d. 1000111 & 0010110

ii. Subtract $(10001)_2$ from $(100101)_2$

iii. Subtract $(10110)_2$ from $(110011)_2$

iv. Add the following binary numbers:

a. 10001 & 11101

b. 101101 & 11001

c. 1011001 & 111010

d. 1110 & 1111

v. Solve the following:

a. 1011011 - 10010

b. 1010110 - 101010

c. 1000101 - 101100

d. 100010110 - 1111010

e. 101001×110

f. 10111×11

g. $101010 \div 110$

h. $10000111 \div 101$

Answers

1. (a) 1011 (b) 10110

   (c) 1011.0111 (d) 1011101

2. 10100

3. 11101

4. (a) 101110 (b) 1000110

   (c) 10010011 (d) 11101

5. (a) 1001001 (b) 101100

   (c) 011001 (d) 10011100

   (e) 11110110 (f) 01000101

   (g) 111 (h) 11011

Chapter 7: THE BASIC COMPUTER ARCHITECTURE

THE BASIC COMPUTER ARCHITECTURE

This chapter deals with providing an overview the internal components of digital computers.

COMPONENTS OF A DIGITAL COMPUTER

A digital computer can be broadly classified as a collection of four components. They are :-

1. Input unit
2. Output unit
3. Central Processing Unit
4. Memory (auxiliary)

A block diagram representation of the above is shown in the figure:

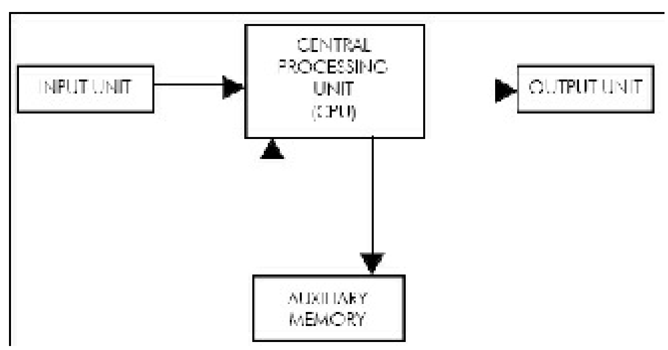


Figure 7.1: Basic Components of a digital computer

The Input Unit

The Input Unit provides an interface between the users and the machine, for inputting data and instruction etc. One of the most common examples is the keyboard. Data can be input in many more forms – audio, visual, graphical etc.

Some common input devices are listed below:

1. Keyboard
2. Mouse
3. Voice data entry
4. Joy stick

5. Light pen

6. Scanner

7. Secondary storage devices such as floppy disks, magnetic tapes etc.

The data in any form is first digitized, i.e., converted into binary form, by the input device before being fed to the Central Processing unit (CPU).

The Output Unit

Like the Input Unit, the Output Unit also provides an interface between the user and the machine. A common example is the visual display unit (monitor) of a personal computer. The output unit receives the data from the CPU in the form of binary bits. This is then converted into a desired form (graphical, audio, visual etc.) understandable by the user.

Some common output devices are:

i) Visual Display Unit (Monitor)

ii) Printers

iii) Speakers

iv) Secondary Storage Devices

The input and output unit collectively are referred to as 'peripherals'.

The input and output units shall be discussed in more detail in the next chapter.

The Central Processing Unit

The central processing unit is the brain of the computer system. The input and output devices may vary for different applications, but there is only one CPU for a particular computer. The specifications of a computer are basically characterized by its Central Processing Unit.

The central processing unit can be further divided into:

1. The Arithmetic Logic Unit (ALU)

2. The Control Unit

3. Main Memory

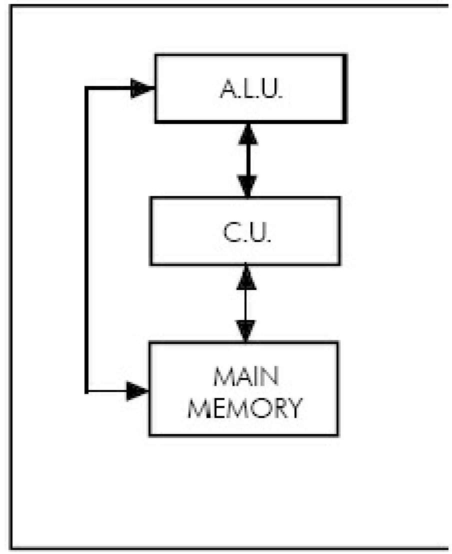


Figure 7.2: The Central Processing Unit

The arrows in the above Figures may represent data as well as control information flow.

The CPU processes the data it receives as input (either through input devices or through the memory). As mentioned earlier the CPU receives the data in the form of binary bits, which it can understand.

The CPU performs many tasks, some of which are listed below:

1. The CPU can perform arithmetic calculations such as addition, subtraction etc.
2. The CPU can perform logical decisions.
3. The CPU with the help of other devices can perform data transmission.
4. The CPU can perform manipulating tasks such as word processing.
5. After performing the required task the CPU may place results in memory or send results to the output device according to the instruction given to it.
6. The CPU with the help of its control unit generates timing signals (also known as enable signals) which provide synchronization between the different devices and the CPU.

As mentioned earlier, the central processing unit consists of:

1. The Arithmetic Logic Unit (ALU)
2. The Control Unit
3. The Main Memory unit

The Arithmetic Logic Unit (ALU)

As the name may indicate the arithmetic logic unit performs all arithmetic and logic calculations on the data it receives.

Arithmetic Calculations

The arithmetic calculations may be addition, subtraction, multiplication, division, exponentiation etc.

Logical Calculation

Logical calculations are basically decision making statements for example, A>B, decides whether is A is greater than B or not; If A is greater than B the statement is true and logical '1' would be generated, otherwise a logical '0' would be generated. Some logical decisions decide the further routing of the program. This will be further explained by the figure : -

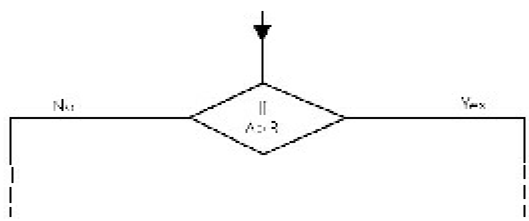


Figure 7.3: Part of a Flow Chart

In the above Figure the decision box has split the flow chart into two.

The functioning of the arithmetic logic unit would be better understood when we discuss the 'accumulator'.

The Control Unit

The control unit controls the entire operations of the computer and the CPU. It controls all the other devices connected the CPU, i.e. Input devices, Output devices, Auxiliary Memory etc. Hence, the control unit acts as the nerve centre of the computer.

The control unit upon receiving an instruction decides what is to be done with it. That is, whether it is to be sent to the ALU for further processing or to the output devices or to the memory etc. In other words the control unit coordinates and controls all hardware operations.

The control unit has an electronic clock that transmits electronic pulses at equal intervals of time. The control unit gives instructions to other devices based upon these pulses. Suppose there are three instructions to be performed. Let the first instruction take three clock pulses to complete; when the fourth clock pulse is received the control unit would start processing the second instruction and so on. Suppose an instruction takes three and a half clock pulses to complete. In such a case the control unit could wait for the fourth clock pulse to complete and take up the next instruction with the fifth clock pulse.

The clock pulse basically provides synchronization between the different parts of the computer. The control unit generates millions of clock pulses per second. The speed at which an instruction is executed depends upon the clock speed which is in MHZ (10^6HZ).

The Main Memory Unit

The main memory also known as the primary memory is a part of the central processing unit and is a combination of both RAM (random access memory) and ROM (read only memory). We shall discuss the RAM and the ROM later but for now we shall define them as follows: -

RAM

The random access memory is a read write memory i.e. information can be read as well as written into this type of memory. It is volatile in nature, i.e., the information it contains is lost as soon as the system is shut down unless 'saved' for further usage by users. It is basically used to store programs and data during the computer's operation.

ROM

The read only memory as the name may suggest contains information that can only be read, i.e., you can't write on this type of memory. It is non-volatile or permanent in nature. It is basically used to store permanent programs such as program for the functioning of the monitor.

The main memory is a fast-memory, i.e., it has small access time. It is because of its limited capacity that it is fast. The main memory contains the programs that are currently being worked on. It passes on this information to the control unit as and when required. In case the CPU wants to access some data that is present in a secondary storage device, this data is first transferred to the main memory and then processed.

The main memory is much more costly than the secondary storage devices. Although the ROM IC's of various computers do not vary much in their capacities, the RAM chips are available in wide ranges of storage capacities. In fact, the capacity of the random access memory is an important specification of a computer.

A larger RAM means larger programs (in terms of memory) can be loaded and executed. Suppose you want to run a 68-KB program on a machine with 64-KB. This means that the whole program can not be loaded into the main memory at once resulting in either the non-execution of the program or a very slow execution.

A 64-K memory means that there are approximately 64000 (65,536 to be precise) storage locations which can store 1 bit of data each.

Different memories can be classified on the basis of there concepts:

1. Access Mode: which means how easily they are accessible.
2. Access Time: the average time required to reach a storage location and obtain its content is called access time.
3. Transfer Rate: the transfer rate is the number of characters or words that a device can transfer per second after it has been positioned at the beginning of the record.
4. Capacity and Cost: the capacity and cost may depend upon the requirement and the budget.

The main memory has a very low access time and a very high transfer rate. It is limited in capacity and costlier than secondary storage devices.

The Cache Memory

Another important concept is that of the cache memory, which is also a part of the CPU.

The cache memory lies in the path between the processor and the main memory. The cache memory therefore, has lesser access time than the main memory and is faster than the main memory. A cache memory may have an access time of 100ns, while the main memory may have an access time of 700ns.

The cache memory is very expensive and hence is limited in capacity. Earlier cache memories were available separately but the latest microprocessors contain the cache memory on the chip itself.

The need for the cache memory is due to the mismatch between the speeds of the main memory and the CPU. The CPU clock is very fast, whereas the main memory access time is comparatively slower. Hence, no matter how fast the processor is, the processing speed depends more on the speed of the main memory (the strength of a chain is the strength of its weakest link). It is because of this reason that a cache memory having access time closer to the processor speed is introduced.

The cache memory stores the program (or its part) currently being executed or which may be executed within a short period of time. The cache memory also stores temporary data that the CPU may frequently require for manipulation.

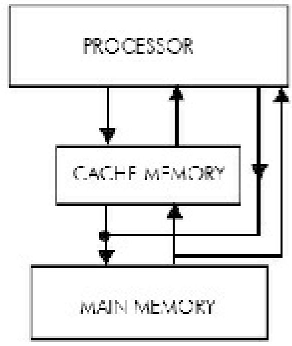


Figure 7.4: Cache Memory

The cache memory works according to various algorithms, which decide what information it has to store. These algorithms work out the probability to decide which data would be most frequently needed. This probability is worked out on the basis of past observations.

We shall discuss the 'memory' later when we discuss the auxiliary memory.

Functioning of the Arithmetic Logic Unit

Register

A register is a combination of memory storage locations called flip-flops. Each flip-flop is capable of storing one bit of information. An n-bit register contains 'n' flip-flops and is capable of storing 'n' bits of information.

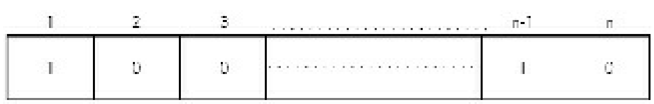


Figure 7.5: n-bit Register

Accumulator

The accumulator is a register that is present within the arithmetic logic-unit. The accumulator stores data, which is either the result of an operation, or which is to be processed through arithmetic and logical operations.

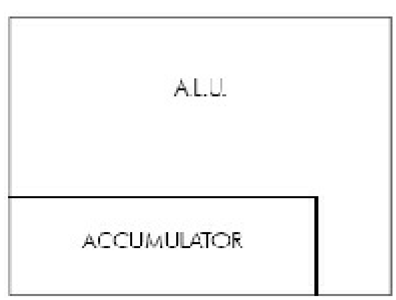


Figure 7.6: The Detailed A.L.U.

Memory Data Register

The memory data register like the accumulator is used to store data. This register holds all data and instructions temporarily as they pass in or out of the main memory.

Memory Address Register

The memory address register contains the address of the memory location (in main memory) whose data is to be transferred into the memory data register.

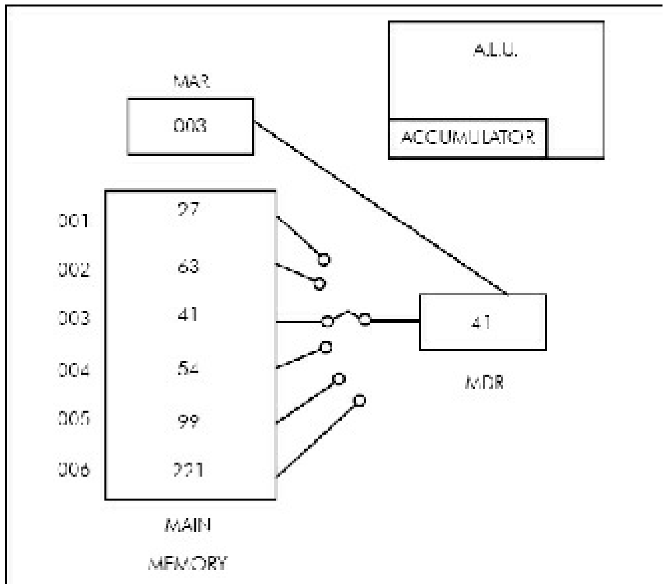


Figure 7.7: Functioning of the MDR & MAR

In the Figure, the memory address register (MAR) contains the address of the third memory location, the data of which is transferred to the memory data register (MDR).

We shall try to explain the functioning of the ALU with the help of an example. Suppose two numbers are to be subtracted. The following steps are involved:

i) Let the first instruction cause the number 13 to be placed in the accumulator. When the control unit receives this instruction it decodes it and performs the controlling and coordination function by sending the number to the accumulator. A special purpose register that holds the instruction currently being processed by the control unit is called the Current Instruction Register (CIR).

ii) The second instruction asks the control unit to send the address of the second number stored in the main memory to the MAR.

iii) The control unit then causes the contents of that specific address of the main memory to be copied to the MDR.

iv) Once the numerical data has been passed on to the MDR, the control unit signals the ALU to perform the SUBTRACT Operation which causes the number in the MDR to be subtracted from the number in the accumulator.

Functioning of the Control Unit

The control unit as said earlier is the nerve centre of the computer. Every instruction before being executed is first interpreted by the control unit. The sequence of operations involved in processing an instruction is known as the instruction cycle. The instruction cycle can be divided into two parts:

1. Fetch cycle
2. Execution cycle

Fetch Cycle

The control unit fetches the instruction from the memory data register and places it in the current instruction register.

Execution Cycle

The control unit then decodes this instruction in the current instruction register and sends the appropriate signal to the concerned device for the execution of the instruction.

The flowchart in the figure describes the functioning of the control unit.

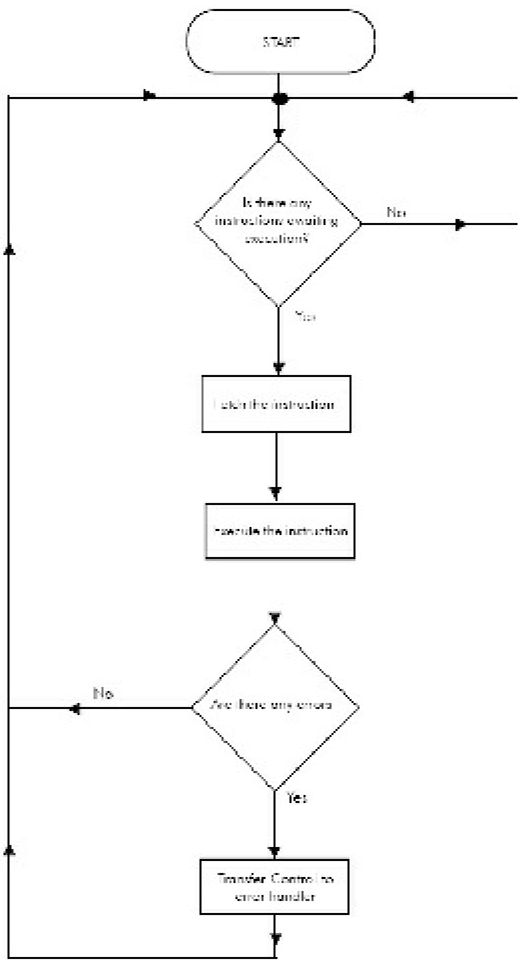


Figure 7.8: Functioning of Control Unit

Let us now turn our attention back to the memory devices.

Memory

Auxiliary Storage Memory

The auxiliary storage memory, also known as the secondary memory is an external (to the CPU) memory. The auxiliary storage devices store system programs, large data files, assemblers, compilers and other programs. In other worlds the auxiliary storage devices are used for bulk storage of data. The storage capacity of these devices is unlimited as an empty device can replace them once the existing device is completely filled. Even the individual storage devices, such as the magnetic tape have more capacity than the main memory.

The secondary memory is permanent in nature, i.e., the information stored in these devices is not lost unless specifically deleted. Secondary storage devices being permanent in nature can also be used for transportation of data from one computer to another.

Secondary storage devices are cheaper as compared to the main memory. The information stored in the secondary memory are first transferred to the main memory and then processed by the CPU. The final result may then be placed in the secondary memory. It is because of this that the access time of the secondary memory is comparatively high. Hence, the data stored in secondary storage devices take more time to process than the data already present in the main memory. In fact the access time for data stored in secondary memory is one thousand times the data stored in main memory.

Secondary memories may also be considered as input and output devices as they provide the information as input and store the final results in the output.

The secondary storage devices would be discussed in detail in a later chapter.

Memory Hierarchy

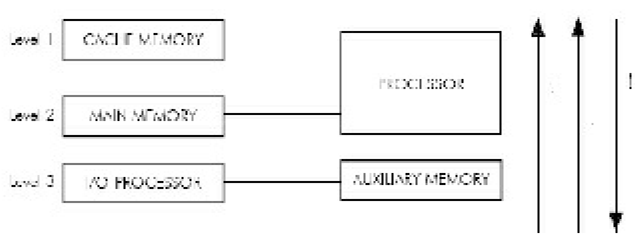


Figure 7.9: Block Diagram Illustrating the Memory Hierarchy

The Figure above is self-explanatory.

Types of Memory

Although various types of memory have been discussed in the previous sections the block diagram given below acts as a good visual aid for memorizing.

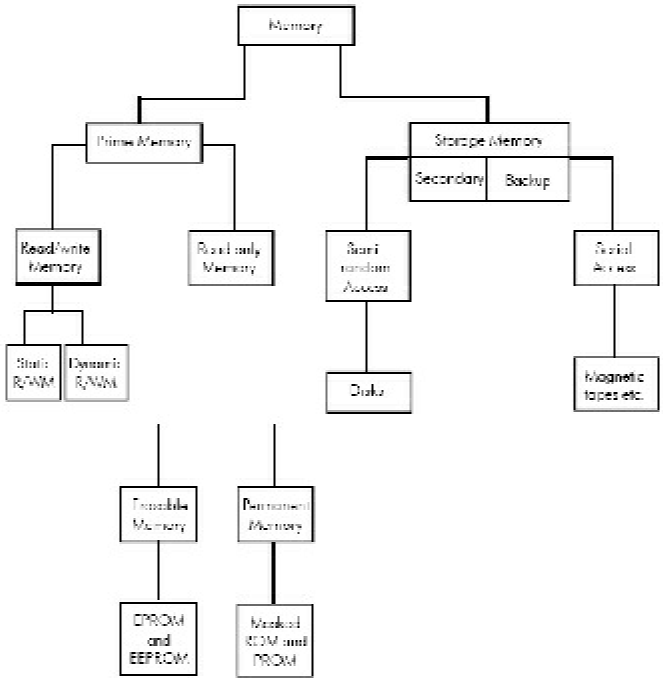


Figure 7.10: Types of Memory

As promised earlier we shall now discuss the random access memory (RAM) and read only memory (ROM) in detail.

Random Access Memory (RAM)

The RAM as mentioned earlier is volatile in nature. It retains the stored information as long as the power supply is on. Its contents are lost when the power supply is switched off. The power requirement of the random access memory chips is comparable to that of the microprocessor itself. It is also partially due to this reason, that the RAM is very fast.

RAM is of two types:

1. Dynamic RAM (DRAM)
2. Static RAM (SRAM)

We shall discuss each of these in detail:

Dynamic RAM (DRAM): The dynamic RAM chips contain a transistor that acts as a gate to a capacitor, which is capable of storing electric charge. The charge on the capacitor indicates a '1' bit and no charge indicates a '0' bit. The charge on the capacitor leaks away after a few milliseconds. Therefore, a dynamic RAM has to be refreshed periodically after every two milliseconds. A D-RAM uses its contents in a very short time even though the power supply is ON. A D-RAM consumes less power and has higher packing density. It is cheaper than the static RAM.

Static RAM (S-RAM): Static RAM's are also volatile in nature but they need no regenerator to retain the data. They retain the data as long as they receive the power. The static random access memory consumes more power and is more expensive. The static RAM chips are more complicated and hence require more space. Static RAM's are faster than the dynamic RAM's Static RAM's have an access time of approximately 85 to 90ns while the dynamic RAM's may take 150 to 200ns to provide information. Static RAM's are recommended for medium sized memories while dynamic RAM's are recommended for large sized memories.

Read Only Memory (ROM)

The read only memory (ROM) contains non-volatile or permanent information. As the name suggests the information contained in this type of memory can only be read; it can not be altered or overwritten. Information is entered into the ROM chip at the time of manufacturing. ROM chips are used for applications which require a permanent information, for example, a program for the functioning of the visual display unit, a program for controlling the working of a washing machine etc.

With the advent of technology erasable ROM's have become available. We shall discuss these and other ROM's in the following section.

Types of ROM:

- Programmable Read Only Memory (PROM): A PROM program is used to record information in the PROM chip. Information once programmed into the PROM chip is permanent and can not be changed or erased. The process of entering the information into the PROM chip is known as "burning the PROM." PROM chips are seldom used in modern day computers, but they still find their use in devices where a permanent ROM is required.
- Masked Read Only Memory (MROM): In the masked ROM, the information is permanently recorded by the masking and metallization process. It is not easy to perform this process as a large infrastructure is required,
and therefore, it is usually the manufacturers who perform this process.
- Erasable Programmable Read Only Memory (EPROM): An EPROM is an erasable PROM. An EPROM can be (re) programmed using an EPROM programmer. Exposing it to high intensity ultraviolet light for 30 minutes (approximately) can erase the contents of an EPROM chip. An ultra-violet source with a wavelength of 2537A (angstrom) is used for this purpose. The process of changing the contents is not convenient, as the chip has to be removed from the board for exposure to the ultra-violet light source. Another disadvantage is that the user can't erase the contents of a single memory location and the entire memory contents have to be erased. The EPROM chip is cheap, reliable and widely

available.

- Electrically Erasable Programmable Read Only Memory (EEPROM): EEPROM is an electrically erasable PROM. Using electrical signals can alter the information and that is why the chip need not be removed from the board. One major advantage that this chip has over the EPROM is that even single memory can be altered, i.e., the entire memory need not be erased and reprogrammed unless required. The change in the contents of the EEPROM chip is made in milliseconds, which is much less than the erasing time for EPROM.
- Non-Volatile RAM: A non-volatile RAM combines a static RAM and EEPROM. Such a device operates as normal RAM but in case the power fails the entire contents of the RAM are stored in EEPROM. When the power is restored, the data from EEPROM is transferred back to the RAM.

Now that you have an idea of the computer's internal architecture we shall discuss the RISC & the CISC.

REDUCED INSTRUCTION SET COMPUTER (RISC)

An important aspect of computer architecture is the design of the instruction set for the processor. The instruction set chosen for a particular computer determines the way that machine language programs are constructed. Early computers had small and simple instruction sets, forced mainly by the need to minimize the hardware used to implement them. As digital hardware became cheaper with the advent of integrated circuits, computer instructions tended to increase both in number and complexity. Many computers have instruction sets that include more than hundred and sometimes even more than 200 instructions. These computers also employ a variety of data types and a large number of addressing modes. The trend for computer hardware complexity was influenced by various factors, such as upgrading existing models to provide more customer applications, adding instructions that facilitate the translation from high-level language into machine language programs and striving to develop machines that move functions from software implementation into hardware implementation. A computer with a large number of instructions is classified as a Complex Instruction Set Computer, abbreviated CISC.

In the early 1980s, a number of computer designers recommended that computers use fewer instructions with simple constructs so they can be executed much faster within the CPU without having to use memory as often. This type of computer is classified as a Reduced Instruction Set Computer or RISC.

CISC Characteristics

The design of an instruction set for a computer must take into consideration not only machine language constraints, but also the requirements imposed on the use of high-level programming languages. The translation from high-level to machine language programs is done by means of a compiler program. One reason for the trend to provide a complex instruction set is the desire to simplify the compilation and improve the overall computer performance. The task of a compiler is to generate a sequence of machine instructions for each high-level language statement. The task is simplified if there are machine instructions that implement the statements directly. The essential goal of a CISC architecture is to attempt to provide a single machine instruction for each statement that is written in a high-level language. Examples of CISC architectures are the Digital Equipment Corporation VAX computer and the IBM 370 computer.

The major characteristics of CISC architecture are:

1. A large number of instructions-typically from 100 to 250 instructions
2. Some instructions that perform specialized tasks and are used infrequently
3. A large variety of addressing modes-typically from 5 to 20 different modes
4. Variable-length instruction formats
5. Instructions that manipulate operands in memory

RISC Characteristics

The concept of RISC architecture involves an attempt to reduce execution time by simplifying the instruction set of the computer. The major characteristics of a RISC processor are:

1. Relatively few instructions
2. Relatively few addressing modes
3. Memory access limited to load and store instructions
4. All operations done within the registers of the CPU
5. Fixed-length, easily decoded instruction format
6. Single-cycle instruction execution
7. Hardwired rather than microprogrammed control

A characteristics of RISC processors is their ability to execute one instruction per clock cycle. This is done by overlapping the fetch, decode and execute phases of two or three instructions by using a procedure referred to as pipelining. A load or store instruction may require two clock cycles because access to memory takes more register operations. Efficient pipelining, as well as a few other characteristics, are sometimes attributed to RISC, although they may exist in non-RISC architectures as well. Other characteristics attributed to RISC architecture are:

1. A relatively large number of registers in the processor unit
2. Use of overlapped register windows to speed-up procedure call and return
3. Efficient instruction pipeline
4. Compiler support for efficient translation of high-level language programs into machine language programs

REVISION EXERCISES

1. The joy stick is a part of which unit
   i) Memory
   ii) Control Unit
   iii) Input Unit
   iv) Output Unit
2. Why are the input and output devices referred to as 'peripherals'.
3. What are the functions performed by the CPU?
4. In a database management system which memory would be best suited to store the data:
   i) ROM
   ii) Non-volatile RAM
   iii) EEPROM
   iv) Auxiliary Storage Memory.
   v) RAM
5. Write a short note on the functioning of the control unit? Explain how the clock pulse provides synchronization among the different parts of the computer?
6. Define 'access time'? Which of the following has the shortest access time.
   i) Cache Memory
   ii) RAM
   iii) ROM Non-volatile RAM
   iv) Main Memory
7. Which of the following memories is the costliest.

i) Main Memory

ii) Ram Chip

iii) Cache Memory

iv) Secondary Memory

8. How does the cache memory decide what data it has to store.

9. Explain the functioning of the memory data register and the memory address register?

10. What does the current instruction register store?

11. Distinguish between dynamic & static RAM?

Fill in the blank

The process of entering the information into the PROM chip is known as ———— PROM.

Chapter 8: SOFTWARE CONCEPTS

INTRODUCTION

Software is a general term, which is used to describe the instructions that are given to a computer. These instructions can be either a single program or a group of programs.

TYPES OF SOFTWARE

Software is generally classified into three specific categories in the computer world:

1. System software
2. Application software
3. Utility software.

System software: This consists of all the programs, languages and documentation supplied by the manufacturer of the computer. This type of software is required to use the computer efficiently and conveniently. These programs allow the application developer to write and develop their own programs.

Application software: These programs are developed by the user in order to perform some specific function for the organization. For example a payroll system to compute the salaries of the employees of an organization is termed as an application software.

Utility software: Utility software may be considered as an application software or a system software which is very often used in the development of a program.

PROGRAMMING LANGUAGES

A programming language consists of words, symbols and usage rules pertaining to the grammar that permits people to communicate with the computer. Understanding of computer software is imperfect without a basic knowledge of programming languages. Programming languages allow the programmers and end-users to develop the programs that are executed by the computer. Many programming languages exist in the world today. Each one of the languages has its own unique vocabulary, grammar and usage. Some of these languages have been created to serve a special purpose (for example controlling a robot), while others are more flexible and general purpose, and are suitable for many types of applications. However, in general, programming languages must cater to the following tasks:

- input/output
- text manipulations/calculations

- logic/comparison
- storage/retrieval

CLASSIFICATION OF PROGRAMMING LANGUAGES

Machine Languages

Machine language is the lowest form of computer language. Programs were only written in binary based machine level language in the first generation computers. The computer understands this language only at its lowest level.

An instruction prepared in machine language has two parts:

1. Op-code: This is the first part and is the command or operation which tells the computer what function to perform.
2. Operand: The second part of the instruction is the operand and it tells the computer where to find or store the data or instructions that are to be manipulated. The number of operands in an instruction varies from computer to computer. In a single operand machine, the binary equivalent of "ADD 0184" could cause the value in a storage location 0184 to be added to a value stored in the arithmetic & logic unit. The single operand format is popular in the smallest microcomputers, whereas the two-operand structure is found in most other machines.

The set of instructions in a machine level language can be divided into four categories:

1. Arithmetic- add, subtract, multiply and divide
2. Controlled- load, store, jump instructions
3. Input/output- Read and write
4. Direct use- Halt, start and end

No arithmetic or comparison operations are done in the primary memory of the computer. Instead, it is done in the ALU's special register called accumulator. Thus, if we need to add two numbers, we require one instruction which will order the control unit to place a number in the accumulator, and another instruction to identify the operation of addition.

Let us assume that operation codes of 01 to 08 are given for doing 8 basic operations of a computer. They are as follows:

Operation	Function Performed
01	Addition
02	Subtraction
03	Multiplication
04	Division
05	Places number in accumulator
06	Accumulator contents placed in memory
07	Performs input device input into accumulator
08	Perform output from accumulator to output device

If we write 05 40 then the computer will place the number in the accumulator that is found in address location 40. If now we wish to add a value 35, that has been stored in another location, then we have to write 01 35. It has to be noted, that the addition command is on the assumption that a number is already stored in the accumulator.

The above example illustrates that in machine language, the programmer has to remember the codes of the instruction and supply the numeric addresses. In addition to the above, he has to keep track of the storage locations of the data and instructions. In machine language the initial coding often took months; it was expensive, prone to errors and error correction was a tedious process.

Symbolic/Assembly Languages

The above-explained process of writing programs was cumbersome. In order to reduce the burden, symbolic language, commonly known as assembly language was developed in the 1950's for second generation computers.

This language permits the use of symbols or mnemonics, which are two or three letter abbreviations, for the function to be performed by the instruction. These are then translated by using a symbolic equivalence table. Assembly language has many of the same features to control registers etc. However, the disadvantage of using binary has been removed. The table below shows some of the mnemonic codes for IBM mainframes.

Function code	Mnemonic	Description
01	ADD	Addition
02	SUB	Subtraction
03	MUL	Multiplication
04	DIV	Division
05	LDA	Load accumulator with value
06	STO	Stores contents of accumulator
07	IN	Read a value into accumulator
08	OUT	Output value in accumulator to output device
09	JUM	Jump unconditionally
10	JGT	Jump to the address location if the contents of accumulator are greater than zero

As is evident, machine language is used by the computer. Therefore, the assembly language software translates the specified operation code into its machine language equivalent before the program can be executed.

Here is an example of a symbolic language program and its converted machine code.

Symbolic language		Machine language	
Function code	Address	Function code	Address
IN		0111	
STO	42	0110	101010
IN			0111
STO	42	0110	101011
LDA	43	0101	101011
ADD	42	0001	101010
STO	44	0110	101100
LDA	44	0101	101100
OUT		1000	

Functions of Assembler

i) The Assembler translates the function code into its machine code equivalent.

ii) It assigns absolute addresses to any symbolic address or label names.

iii) It places each instruction in central memory.

iv) It identifies indirect addresses from direct addresses, and sets the appropriate bit in the address portion of the instruction.

v) It checks the syntax of each instruction and generates error messages.

vi) It provides, optionally, a cross reference table between all symbolic names and their absolute addresses.

vii) It instructs the control unit to execute the program after all errors have been corrected.

Advantages of Assembly Languages

i) They save time and reduce detail as compared to machine language.

ii) Lesser number of errors are made, and also errors are easier to detect.

iii) Assembly programs are easier to modify than machine language programs.

Disadvantages of Assembly Languages

i) Writing a code is time-consuming.

ii) Assembly languages are machine-dependent.

High Level Languages

The disadvantages of using assembly language brought about the development of higher level languages. Unlike the assembly programs, high level language programs may be used with different makes of computers with little modification. High level languages are easier to learn than symbolic languages; they require less time to write, are easier to maintain, provide better documentation, and 4 or 5 low-level instructions are reduced to a single high level statement. Some of the popular high level languages are given in the table below.

Language	Meaning	Main Application Area
FORTRAN	Formula Translator	Scientific & Engineering
COBOL	Common Business	Oriented language Commercial
ALGOL	Algorithmic language	Scientific
RPG	Report Generator	Commercial
APL	A Programming Language	Time Sharing System
PL/1	Programming Language 1	Scientific/Commercial
BASIC	Beginners All purpose Code	Symbolic Instruction Teaching
PASCAL	Named after the French Philosopher	Teaching

Classification of High Level Languages

High level languages are sometimes classified as

- Procedure oriented languages
- Problem oriented languages, and
- Interactive programming languages

Procedure Oriented Languages

Procedure oriented languages provides easy to use features which allow the programer to write processing steps required for a particular application. Examples of procedure oriented languages are COBOL, FORTRAN, PL/1, etc.

Problem Oriented Languages

These languages attempt to solve processing requirements with minimal programming effort; thereby, allowing the user to concentrate on the desired results, rather than on the individual steps needed to get these results. A typical example of a problem oriented language is RPG.

Interactive Programming Languages

These languages have features which allow the user to interact with the program in a conversational fashion. A typical example is BASIC language.

Fourth Generation Languages

Computer people refer to the machine language era as the first generation, the symbolic codes one as the second generation, and the advent of the high level languages as the third generation. Successive generations of languages brought about an increase in the programmers' productivity. These generations of software have now been followed by the emergence of software vendors, offering a variety of application development tools, aimed at further productivity improvements. These tools are collectively known as 4th Generation Languages (4GLs).

Essentially, a 4GL tool interacts with a DBMS (Database Management System) software to store, manipulate and retrieve the data required to satisfy user requirement. In contrast to a high level language, which is procedural, a 4GL is a non-procedural language, in the sense that it allows the user to simply specify what the output should be, without describing all the details of how data is to be manipulated to get the results.

A clear-cut definition of a 4GL is not possible, because each tool or language is vendor specific. In general, however, we have the following classification:

i) End user oriented 4GLs: These are designed for applications that process low data volumes and run on mainframes, and may be used by users or programmers. They have their own internal data base management software, which in turn interacts with the organization's DBMS. Non-computer professionals use these products to query databases and develop their own applications, and generate reports with minimum training.

ii) These tools are offered by the same suppliers who also supply the complex DBMS packages to the organization. These tools offer a larger set of commands than the end user 4GLs. They are also able to handle larger volumes of data and are generally used by programming specialists. These include query languages, application generators and report generators.

The following chart depicts some of the major differences between higher level languages and 4GLs:

Third Generation Languages	4GLs
i) Used by professional programmers	May be used by non programmers also
ii) Require task performance specification (how)	Require specification of what task to perform (what)
iii) All alternatives are specified	Default alternatives are built in
iv) Require large no. of instructions	Require far fewer instructions
v) Code difficult to read, understand	Code easy to read and maintain
vi) Originally developed for batch	Developed primarily for online
vii) Can be difficult to learn	Easy to learn
viii) Difficult to debug	Errors easier to locate because of shorter programs and use of defaults
ix) Typically file oriented	Typically database oriented

Object Oriented Languages

Object Oriented Programming (OOPS) has been around since the 1960's. However, it was only in the eighties that object oriented languages became a major consideration in software development. This was due to the increasing emphasis of users on being provided with an easier way of doing their computing, in which he wanted all his needs to be fulfilled through windows, buttons and menus (all objects).

The basic philosophy of object oriented languages is to encapsulate the data and procedures (methods) together into an object, so that the conventional method of separating the data from the procedures is eliminated, and the programmer need not keep track of what is happening to the data each time a program is run. Once objects are programmed, they are reusable. Languages like C, C++, JAVA are examples of object oriented languages and have become today's programming languages by choice.

LANGUAGE TRANSLATOR PROGRAMS

These are programs that translate programs written in other languages into a machine language instructions code, which the computer can execute. There is also a program that can help a programmer to write his program by providing creation and editing facilities.

Translation programs are known by various names:

i) Assemblers: An assembler translates the symbolic instruction code of programs written in assembly language into machine code .

ii) Interpreter: An interpreter translates and executes each program statement, one at a time, instead of producing a complete machine language program, like assemblers and compilers do.

With an interpreter, the source program is not assembled into an object program. The results are computed immediately after an instruction has been translated. This process allows very efficient use of computer and programmer time during the debugging of the application.

The interpreter need not be a software program which is loaded from external sources. It may be permanently residing in a ROM program. Microsoft BASIC interpreter uses such a program. Some of the Interpretive languages are BASIC, LISP, FORTH, APL etc.

iii) Compilers: A compiler is a program which produces a machine level program from the specifications of a high level language, by generating one or more than one machine instruction for each high level instruction, i.e. it translates the higher level program into machine code.

The compilation process has several phases:

1. Parsing: Parsing is the process of breaking down

   i) a statement grammatically, in terms of its functions, syntactic relations, etc., and whereby

   ii) the statements of the source language are examined and analyzed, whereafter

iii) the data dictionary comprising of data descriptions is built, and subsequently,

iv) a coded representation of the statements is created.

v) a copy of the source program is printed, and

vi) if necessary, appropriate diagnostic messages are issued.

2. Mapping: in the second phase, a mapping process is performed. The dictionary entries are examined, and the declarations are mapped into the data formats of the object computer.

3. Generation of object code: in the final phase, the appropriate object code is generated to handle the expressed operation.

GENERATORS

The generator is a routine that performs a creative function: for example, a report generator, a program generator. A report generator creates a report requiring little or no calculations or complex logic. In this process the programmer writes specifications for the reports rather than the program instructions necessary to generate the report. The specifications may be the print positions in which the data fields have to be printed, totals required, etc. The specifications are subsequently converted into a set of specifications and interfaced with the report generator processor. The report generator then produces a report as per the format specified.

THE EDITOR

The editor is the most often used systems program. It is an interactive program that is stored in the memory and allows the user to write, to program, to generate text, or to make modifications to either of these. The editor is a systems program that is typically stored on the hard disk and, whenever needed, is called into the RAM. All source programs for assemblers and compilers are typically written with the editor.

THE LOADER

The loader is a short simple program that is used to load a program into the computer's memory. The loader program is a sequence of instructions that transfer the program from the hard disk/floppy to the memory. The loader is, typically, permanently stored in the ROM of the computer.

PROGRAM LIBRARY

A library is a collection of programs which can be searched by a linking loader for requested programs. The loader first loads all the user's supplied programs and then searches the library to find program names that match unsatisfied external references. Systems may allow any number of libraries to be specified. A linking loader will search each one in turn.

THE MONITOR

Almost all microcomputers use some form of monitor. Typically it is stored in ROM and performs some of performing functions:

i) enter or load instructions and data

ii) change contents of memory locations and registers

iii) display contents of memory locations and registers

iv) execute programs

SOFTWARE: NATURE AND QUALITIES

Any engineering activity ultimately results in some product. The product built by a civil engineer could be a building, while an electronic engineer comes out with a chip, an electrical engineer builds a circuit and an aerospace engineer finally lands up with an aeroplane or aircraft. Now what do you expect out of a software engineer? Well, the product of a software engineer is a "software system". Although it is not tangible, yet it is a product. This product is similar to the rest of the products in some ways and also very different in many other ways. The important property which distinguishes software from the rest of the products is in its being “malleable” i.e., the modification in the design of the product is comparatively easier as compared to the other tangible products.

This property is often misused by people. Actually, it is not as easy as it seems. It is possible to make modifications in the rest of the products also, for e.g., changing the basement of the building. But by considering the enormity of the task, it is generally not taken lightly and attempts are not made to first change its design and then the product itself. The impact of changes are shown very extensively. Whereas, when the changes are to be made in software, these types of attempts are made very easily and software engineers are simply asked to make the modifications. But in practice, making the necessary modification in software is not an easy task to do.

The code can be changed easily in the editor, but meeting the targets might not be as easy. Here comes the need for treating software as any other engineering product. The enormity of changes in software should also be studied as deeply as we do in rest of the products. Instead of taking this property merely as change in text editor, it should be considered as the change in design first. Then the impact of the change should be analyzed, and only then should the task of modification be started. The whole story is narrated just to emphasize one point and i.e., “discipline”. That means the malleability property should be exploited, but in a disciplined manner.

One more characteristic that distinguishes software from the rest of the engineering products is in its being human intensive. That means the emphasis is on engineering, rather that on manufacturing, unlike other engineering products. In most of the engineering products special attention is given to manufacturing, as it is the factor that determines the cost of the product. The process has to be managed and monitored carefully to lessen the defects. The same holds true for computer hardware products, but not for software. Manufacturing is merely a process of duplication for software. The process of software production is concentrated on designing and implementing. The goal of the whole process is to meet certain criteria, and thus the production of a “high quality” product.

Any engineered product is supposed to meet some needs and fulfill certain requirements. These are generally clear in most of the engineering products. For e.g., a building is supposed to perform the function of a residential place, and have the ability to accommodate the number of people it is built for. It is expected that it will not collapse with the weight, and that it should have strong window panes that can withstand the onslaught of that strong winds. Similarly, an airplane is expected to complete the flight smoothly and not crash because of some faculty design or some manufacturing problem. We do not have such distinct sets of specifications for a software product. The qualities that are expected out of a software product are often a combination of specifications and the qualities of the design.

This chapter will discuss the qualities that a software product and the production process should possess. These qualities ultimately become the benchmarks of software engineering.

Software Qualities

When we talk about the qualities expected from a software the list becomes very long. These qualities can be expected by the user, by the producer or by the leader of the project. The qualities can also be expected from both the product and the production process.

The user would like the product to be reliable, easy to use, efficient and accurate, whereas the producer would want it to be maintainable, portable, extensible and verifiable. At the same time the manager of the software project would want the software project process to be productive and easily controllable.

The qualities of software can broadly be dividend into:

(i) External vs Internal Qualities

(ii) Product vs Process Qualities

(i) External: The qualities a software should possess can be divided into internal and external qualities. Internal qualities deal with the qualities from the developers' point of view, whereas the external qualities are the qualities expected by the user. The internal qualities are the ones which are responsible for the structure of the software and, in fact, these are the ones which help developers in achieving the external qualities. Users are generally not bothered about the internal qualities, whereas the developers concentrate on internal qualities to achieve the target of external qualities; e.g., the internal quality of verifiability is responsible for achieving the external quality of reliability. However, sometimes it is difficult to differentiate between internal and external qualities as the distinction is not very clear.

(ii) Product: The product and process qualities are also very closely related as in some cases of internal and external qualities. There are some properties that apply to both product and process. For example, the careful planning of the test data in the process of design and development of the product will increase the reliability of the product, whereas a quality like efficiency is expected from both product and process.

When we talk about 'product' the definition that comes into our minds is “What is delivered to the customer”. This definition, when considered broadly seems fine, but not when seen from the customer's and developer's perspectives individually. This is true from the customer or user's point of view, but the developer includes the requirement specification, design, source code, test data, the object code and also the users manual in the product. That means all the parts that are produced during the production process are the constituents of the product. It is also possible to combine the different subsets of the same product to cater to various customers.

For example, the object code of hardware can be sold to a company which is installing the machine, whereas the source code and design could be sold to the software vendor who can make modifications in the same to produce some other model of the same hardware. At the same time the manual and the object code could be sold to the software dealer. Thus, all the four people, i.e., the developer, the company installing the hardware, the software vendor and the software dealer, see the same product from four different angles and use them for different purposes altogether.

This type of dealing comes under configuration management, which is again a part of the software production process. Configuration management checks the maintenance and control of the relationships among all the related pieces of the various versions of a product.

Representative Qualities

We will now talk about the qualities of software products as well as the process. We call them "Representative Qualities". We will be analyzing, the "RQ" in terms of the classifications discussed above:

1. Correctness, Reliability, and Robustness: Although all these three terms can be used interchangeably to find out whether the software is performing its functions as per requirements, they are sometimes used with different connotations by different people. Let us discuss them in more detail.

   A program is said to be correct if it functions as per the specifications or the requirement. That means it is doing whatever was expected out of it.

   Although there is no specified set of specifications available, whatever specifications we talk about are written in natural language and are often full of ambiguities. Regardless of the ambiguities present, the definition of "correctness" holds true and is the most desirable property for software systems.

   Correctness depends solely upon comparison – that is, the comparison between the set of specifications and the product itself. Higher degree of correctness can be easily achieved by being more systematic and precise in specifying the requirements. There are various methods available for assessing the correctness, depending upon the needs and requirements of the user/developer/customer /project leader. They include the experimental approach and the analytical approach. The correctness can also be enhanced by using high level languages that support extensive static analysis or standard algorithms.

   A software is said to be reliable if the user can depend upon it. A reliable software is defined in terms of probability i.e., the software will function (as expected) for a specified time interval.

Whereas software "correctness" is an absolute quality term, "reliability" is a relative term. This means that if the system deviates from its specifications even a bit (be that for better or worse) the system is labeled as "incorrect", whereas when we talk of its reliability such type of deviations do not matter i.e., as far as it is giving expected and correct results we call it reliable. Software products are commonly released along with a list of "Known Bugs". Users of the software take it for granted that "Release of a product is "buggy". This is one of the most striking symptoms of the immaturity of the software engineering field as an engineering discipline.

In other engineering disciplines, a product is not released if it has "bugs". One cannot expect the release of a building with a warning not to put nails in the ceilings. Design errors are extremely rare and are worthy of coming on the front page of newspapers. If a building collapses, the engineers and designers have a good livelihood of being prosecuted in court.

In contrast the mistakes made by software engineers are generally treated as unavoidable. In spite of having apprehensions about these mistakes, we expect them. Where we get guarantee cards for most of the engineering products, with software we get a disclaimer saying that the software manufacturer is not responsible for manufacturing defects. The day we achieve the same degree of reliability for software as for other engineering products, we will be in a position to put software in the category of engineering discipline.

The Figure below illustrates the relationship between reliability and correctness. It says that the set of correct programs are the subsets of reliable programs, but this doesn't hold true vice-versa. It doesn't hold true in practice either. Actually, the specification is a model of what the user wants, but the model may or may not be giving an accurate statement of the user's needs and actual requirements. What all a software can do is to meet the specified requirements of the model but cannot guarantee the accuracy of the model.

That shows that the Figure below is of an idealized situation that might or might not be achievable in practice. This is only to be expected as there are uncountable obstacles in achieving this target. It can be explained by realizing that though sometimes the applications might be "correct" the designing could have been based on "incorrect requirements." In such a case the software cannot be guaranteed to satisfy the customer.

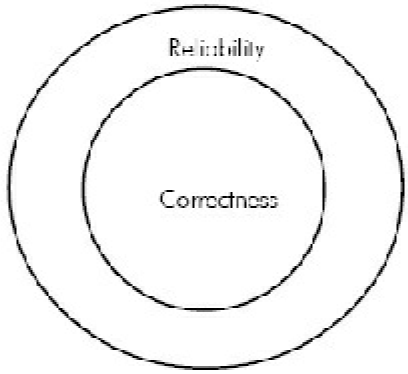


Figure 8.1: Relationship between Correctness and Reliability

A program is said to be “robust” if it behaves “reasonably” even in unanticipated circumstances. For example, when a program encounters incorrect input or some other problem, and it generates a run time error as soon as the function is performed, then the program cannot be called robust.

Robustness is a difficult quality to define. As a set of actions cannot be specified for various problems like incorrect data etc., it is close to “correctness” and “reliability”.

When the question of measuring robustness comes in, the code written depends upon the application area. An application developed for first time users should be prepared keeping in mind all types of input errors, whereas when talking about a system prepared for an aircraft, extra care and robustness is required.

We can say that correctness and robustness are closely related, without any single measure to distinguish them. We can say that if the source requirement is put in the specification the final product becomes a matter of correctness, whereas if the requirement is not specified explicitly the matter is of robustness. Now here reliability comes in, as, even incorrect systems give perfect or at least good enough results.

Correctness, Robustness and Reliability are also applied to the software production process. A process can be said to be robust, if it takes care of unexpected changes in the environment. A process is reliable if it constantly leads to the production of high quality products.

2. Performance: Any engineering product lays stress on the performance of a product. But in software engineering, the performance is expected along with efficiency. A software system can be called efficient only if it uses the resources economically.

Performance greatly affects the usability of system. Say, for example, if the software system is too slow, it reduces the productivity of users, making the task cumbersome; if the software system is using too much of disk space, then its cost is increased, thus reducing the viability; if it uses too much of memory, then it not only affects other applications but also gives errors. It also becomes slow, as the operating system will be busy in maintaining a balance between memory usage and the applications.

Performance also decides the suitability of a software system. An algorithm can be used very nicely for small inputs but does not work for larger inputs at all.

Performance of a software system can be evaluated in many ways. One way is to measure its efficiency by analyzing the complexity of the algorithms. Analysis of the complexity of the algorithms only provides an average or the worst case of information and not the specific information about a particular system.

For specific information, techniques of performance evaluation are used. The three basic approaches for evaluating the performance of a software system are “measurement”, “analysis” and “simulation”. While using “measurement”, the actual performance of the system is monitored by collecting data while the system is working, and then finding out the bottlenecks of the system. In “analyzing” a model of the system is built and then analyzed; whereas in “simulation”, a model that simulates the product is built.

An analytical model is not as expensive as a simulation model could be. The analytical models are easy to build and are generally based on querying the theory, but they are less accurate as compared to simulation models, which are difficult to build but are very accurate. For getting best results the two techniques can be combined together i.e., in the beginning of the project an analytical model can be applied that gives a general understanding of the project, and later on the simulation technique can be used on the critical areas of study, pointing out the problem areas .

Performance is also applied in the process. But while applying in process we call it productivity and is regarded as an independent quality.

3. User-friendliness: A system is said to be user-friendly if the users find it “easy to use”. This “ease of use” may vary from user to user. A novice might find the verbal messages user-friendly, an expert programmer ignores them without even reading them. Similarly, a new programmer or a non-programmer may find the use of commands very difficult, whereas a programmer may find the use of commands easier.

“The user interface" constitutes an important component when we talk about user-friendliness. A novice may find the use of the mouse a better option when working with a window interface, rather than typing down a command; whereas an experienced user will find it more convenient to type down the command, rather than navigating through the window, to find out the command he wants to execute.

User-friendliness is not restricted to user interface only. It also depends upon the user operator interfaces. Not only that, it also depends upon properties like correctness, performance, etc., as mentioned above. The system producing incorrect output can never be user-friendly, no matter how nice its interface is. Similarly, a beautiful interface with a perfect color combination, back ground, graphics but with very slow processing can never be called user-friendly.

When we talk about embedded systems, there is no such thing as "interface". The interaction is between the hardware and the other software systems. In these cases user-friendliness is measured in terms of its adaptability to the environment and the configuration of other software systems.

4. Verifiability: This property holds true if its properties can be verified easily. As correctness and performance are the properties which we would like to verify, the properties can be verified by means of analysis or testing.

Modular designs, disciplined coding practices and the use of appropriate programming languages help in making the system verifiable.

Although verifiability is an internal quality it is sometimes used as an external quality too.

5. Maintainability: By "software maintenance" we generally mean the modifications required after the release of the software in the market.

Earlier maintenance meant only removing the errors and the bugs. A considerable amount is spent on this simple word "bug". But now maintenance adds on this "bug fixing". It includes the additions or enhancements to the products which were introduced, there, when the project started or which were incorrectly stated.

The word "maintenance" does not go with the word "software". By maintenance we generally mean the maintenance of wear and tear of the product. But in software there is nothing termed as wear and tear. However, since this is the "in" thing, now we are forced to use it.

Maintenance cost sometimes exceeds 60% of the total cost of software. To take preventive measures to reduce this high maintenance cost, we divide maintenance into three types: corrective, adaptive and perfective maintenance.

Corrective maintenance takes care of the removal of the errors present at the time of delivery of software.

Adaptive maintenance looks after the adjustment of application to changes in the environment.

Perfective maintenance is bothered about the changes in the qualities of the software.

Maintainability can be broadly classified into repairability and evolvability. The former takes care of fixing up the defects, whereas the latter makes sure that changes can be incorporated as per new requirements.

Repairability is generally a product quality, and mainly affects the reliability of the software, i.e., as the reliability increases, need for repairability decreases. In as much as evolvability is a product and a process quality, it is directly related to the cost of software production. That means that as the cost of software production increases and complexity grows, its evolvability gains more importance. The process must be able to accommodate new management and organizational techniques.

6. Reusability: Reusability is quite similar to evolvabilty. In evolvability modifications are made in the product to take out a new version of the product, whereas in reusability the same product is reused with some modifications. Although it seems easy, it is very difficult to build variable products. While reusability is an important tool for reducing software production costs, examples of reusable software are very rare.

   Reusability is applied to the process as well. The same process can be reused for building up different products.

7. Portability: Software is said to be portable if it can be run in different environments. By “environment” we mean the hardware platform or a software environment such as a particular operating system.

   Portability refers to the ability to run a system on different hardware platforms. As the money spent on software and hardware increases, portability gains more importance.

   For most applications, it is important for the software to be portable across operating systems, or we can say that the operating system should provide for portability across different hardware platforms.

8. Understandability: Some software systems are easy to understand whereas others are not. For example, a program written to launch a missile would be difficult to understand no matter how simply it is written.

   This is an internal product quality and helps in achieving evolvabilty and verifiability. Whereas, taking it as an external quality, it is a component of user-friendliness.

9. Productivity: This is a quality of the software production process and is used to measure the efficiency of the process. An efficient process results in a faster

delivery of the product.

Productivity of software is of great interest due to the increasing cost of software, yet it is difficult to measure. As in other engineering disciplines, we will see that efficiently of software is strongly affected by automation.

10. Timeliness: It is again a process-related quality which talks of timely delivery of software. This timeliness is generally lacking in software production processes.

It is related to other qualities of software also. For example, a timely delivery of software that lacks reliability, or is incorrect, is of no use.

Timeliness requires careful scheduling, work estimation and predefined milestones.

One reason for late deliveries is the ever-changing user requirement at various stages of software production.

11. Visibility: A software development process in said to be visible if the documentation of all its steps is done properly and clearly. "Transparency" and "openness" can be inter-changed with the term "visibility". It is both an internal and external quality. Visibility requires not only the documentation of all the processes, but also the current status of intermediate products. A product is visible if it is clearly structured, such as a collection of modules, with clearly understandable functions and easily accessible documentation.

PROGRAMMING LANGUAGE EXAMPLES

A large number of high level languages have been developed for specific requirements. Some of the commonly used languages for various applications are:

I. Scientific and Engineering:

BASIC

FORTRAN

II. Business and Commercial purpose

COBOL

BASIC

III. Text Processing

Lisp

SOSL

IV. General Purpose

PASCAL

ADA

C

V. Artificial Intelligence (AI)

PROLOG

LISP

COMPUTER FILES

When we examine the way we do our office work, we discover that data or information is either written by us on paper or is received on a paper by us. After reading the contents and taking necessary action the paper is then filed in a file. This file has a name or number which has been assigned by us. This name is given keeping in mind that if we wish to refer to this paper, say after six months, we are able to remember and correlate this name with the paper. Alternatively the files could be according to the various departments/functions of our organization, and a list of names could be maintained centrally for easy reference.

The computer also has to store data and programs in its secondary memory, which is brought to its primary memory, where the program acts on the data in order to give intermediate or final outputs for our consumption. The computer also requires a methodology for storing and retrieving this data and programs. Like, in the physical world, we store data into files and place them into a filing cabinet, similarly we store data into computer Files and store them in the Hard Disk or any other secondary storage. In the physical world, if we require to read the data, we open the filing cabinet, locate the file name, pull out the file, and then read it. In the computer also, whenever data is required to be read or acted upon, it will be brought out of the hard disk by referring to its name and then opening it in the RAM or primary memory.

Types of Computer Files

Depending on the computer application and its design, computer files are normally of the following types:

1. Master Files: This term generally represents a file in which up-to-date information about various data items are available along with other data items. In this sense, it becomes a master file for referring and for updating, whensoever the status of the data changes. For example, the year – to – date earnings of an employee are usually available in the master file of the Payroll application. Likewise, the present balance of an item in the stores will be available in the master file of the Inventory Management Application.
2. Transaction Files: Daily transactions occur in an organization, which have to be recorded, so that the master file information can be updated periodically, as per the demand of the Application to which the transaction data is relevant. For example, in a store management system application, goods are being received daily and are being issued also as per the issue requests from the manufacturing department. All issues and receipts are entered into a file, pending master file updation, or to be processed for other reports. These files which contain transaction data in its raw form are called transaction files. Necessary programs will use these transaction data in order to calculate item balances in the master file or to produce a daily issue/ receipt statement, etc.
3. Program Files: Data entered into a transaction file has to be processed .i.e. manipulated and transformed in order to produce reports or give answers to ad-hoc queries. This processing is done through the use of programs written by programmers. The programs are written in a computer language using the editor available with the operating system, or alternatively, an editor bundled with the compiler/interpreter of the language being used to write the program. These programs are then saved with a file name having an extension as per the language norms. These Files are called Program Files.
4. Backup Files: All computer files in normal circumstances are stored on the hard disk of your computer. These files are accessed whensoever needed for insertion, deletion or updation, or for queries and report generation, and/or for printing. However, every user of an application, with due passage of time becomes reliant on the computer to fulfill his information needs. As such he has to protect his information resource from any unforeseen happening. This could range from a Hard disk crash – to a virus attack – to wrong feeding of fresh data – to file corruption and to the ultimate destruction of the computer due to a natural or unnatural calamity.

   As such, a prudent user will normally take a backup of his data, at predetermined intervals of time, on to a removable media like a floppy disk or a CD or a magnetic tape, and store it separately. The files thus stored on these media are called backup files and are created using a special backup software, usually provided along with the operating system. In case of a mishap these backup files can be restored back on to the hard disk using the restore facility of the software.

5. Specialized Files: In addition to the above main files, every computer center will also have certain specialized files to help with the routine computer centre operations, system maintenance and so on. These files are quite varied. Some of them are log files, index files, history files, data dictionaries, etc.

Types of Processing

As mentioned above transaction data being generated at every transaction is used to update the master data. This updation is achieved by using suitable commands or programs. There are various options available to do this activity depending upon the computer environment available, the volume of transactions and the need of the application for which the updated data is required. Some of the common processing types are discussed below:

1. Batch Processing: Consider a typical Payroll system in a medium sized organization. The payroll system requires to capture the attendance of every employee during the month, the leaves availed by him with pay and without pay and so on. At the end of the month, keeping this attendance record as the basis, the salary of each employee is calculated and a salary slip is generated. Since the data (leave record) is required at the end of the month, it is advisable that all leave forms/attendance records be clubbed into a batch or batches and a transaction file of the same, containing records on staff/employee number basis be created . At the end of the month this file could be used to update a master file, containing the salary structure of the employee and his salary computed for the present month, after considering his leave record.

   Some of the main reasons for choosing the Batch Processing mode are:

   a. Processing time is reduced since data entry on terminal is slow, and if done offline, the transaction file so obtained can be directly used when processing is to be done. This will considerably improve processing speed.

   b. In the batch processing scenario , master files need not be online all the time. This solves many security and privacy issues.

   c. Batches of data can be input by outsourcing. This can lead to significant cost savings.

d. Another significant advantage of this mode of data processing is that it allows the raw data to be validated by separate validation programs before being used for actual processing.

2. Real Time Processing: In this environment the master file records are updated as soon as a transaction is entered into the system. As is evident, no transaction file will be created separately. The obvious advantage of this type of data processing is that a more current master is maintained than in the batch processing mode.

For instance in the stores management systems application, a storekeeper or a materials manager will be able to see the availability status of any item as soon as it is entered. Of course, a slight delay between receipt of the item in the store and the actual data input always exists in real time processing. Validation rules are inbuilt in real time environment data entry programs. For example if an item number is wrongly typed in, the system may respond with an error message ,forcing the data entry operator to correct the mistake.

The drawback of a real time environment is that it is an expensive way of setting the infrastructure and maintaining it. For example backup procedures have to be more elaborate, unwarranted access by unauthorized personnel will have to be guarded against and, finally, human errors are more difficult to detect in the real time environment.

REVISION EXERCISES

1. Mark True or False.

   a. A linker is a program which links all unsatisfied external references in the program with program libraries.

   b. A loader program typically resides in the hard disk of the computer.

   c. A compiler examines and executes the program one instruction at a time.

   d. COBOL is a high level language used for scientific applications.

   e. Machine language is written in binary code.

   f. C language uses mnemonics.

   g. Application software is written using system software.

   h. Operating system is a system software.

   i. Report Generators are generally classified as 4GL's since they require the programmer to specify all the instructions and specifications to create a report.

   j. 4 GL's are both user oriented as well as machine oriented.

2. Compare higher level languages of the third generation with 4th generation

languages.

3. What are the steps in the compilation process of a program.
4. Match the following:

a.	BASIC	a.	Mathematical computations
b.	Assembler	b.	French Philosopher
c.	Editor	c.	Write programs
d.	PASCAL	d.	Teaching
e.	Loader	e.	Translate to object code
f.	Compiler	f.	Symbolic code
g.	FORTRAN	g.	Booting

Chapter 9: OPERATING SYSTEMS

Computer hardware provides us with the means of processing and storing information. However, the 'bare' machine on its own is virtually useless. In order to make the computer perform useful work for us, it is has to be 'driven' by means of programs-software which specify the tasks to be done. The combination of hardware and software provide a total usable system. Software can be classified into two distinct groups: system software and application software.

Application software, as the name suggests, consists of the programs which carry out the specific processing required for users applications, such as an accounting system or an engineering computer-aided design package. System software is not application specific; it is oriented to the needs of the hardware and facilities the development and running of applications. The most significant part of system software is the operating system, which is present in all computers except for a few very specialized applications.

The role of the operating system is to complement the hardware by providing a layer of services which manage the resources of the hardware and permit the users to drive the system. In general, the user will not be aware of the union in effort. Indeed, many system facilities could be implemented by either hardware or software, a common example being floating point processing. (In many computers, there is no in-built hardware available to perform floating-point computations, which therefore has to be implemented using software routines). The situation is further complicated by the existence of firmware which is a program encoded in a hardware form, usually in Read-only Memory (ROM). Firmware is often used to provide very basic services at a functional level just above the hardware (eg. The bios in PC). Again, the boundary between hardware and firmware is imprecise and in any case, is not important for most users.

HISTORY AND EVOLUTION

The evolution of operating systems has been driven by technological advances and by the demands and expectations of the users. An examination of this evolutionary process helps us to understand the workings of modern systems and to better appreciate their essential principles.

The very earliest computers, provided little in the way of support for their users; switches and lights were the first input and output devices. Programs were entered by using a set of switches to define a memory address value, then using another (or possibly the same) set of switches to specify an instruction word which was then entered into the memory location. This was repeated for each word of the program. The program was started by setting the program counter to the first instruction word and pressing a start button. The first step towards improving and simplifying computer use was to address the problem of loading the program. Reducing the human involvement in this process implied preparing the program in some offline form, then transferring this into the computer memory via an input device such as a card or paper tape reader.

In order to read from a card or paper tape reader, a loader program (is a program which read from the input device and set up a program in the memory) had to be established in the computer memory. In the first place, which prompts the question-how do you load the loader! One solution, of course, is simply to enter the loader manually, as before. However the idea was born of building into the computer a facility whereby, on startup, the computer automatically read a primitive loader program written on, for example, a single card. This basic loader then executed and read in a larger, more extensive, loader program, which could then load any user program. This arrangement was referred to as boot strapping, derived from the idea of pulling oneself up by the bootstraps; the technique and the term survive to the present day, although boot strapping is generally reduced nowadays to booting.

In the 1950s , computer were very expensive, certainly in relation to their throughput measure in today's terms. The early pre-occupation, therefore, was to get as much use out of them as possible. This drive toward 100% utilization of the processor has not entirely disappeared today but is now much less important than usability and peak processing power.

As the hardware steadily improved, the execution time of programs fell. This trend had two very critical consequences, which were to span on rapid development of early operating systems:

The set up time - i.e the time between jobs spent loading the next program and data-become disproportionate to the run time of the job.

The input-output devices were seen to be much slower than the processor speed.

The processor spent most of its time idle, waiting for a card to be reader punched or a character to be printed.

Around 1960, a revolutionary new computer, called ATLAS, was designed by a team from Manchester University and the Ferrants company. This is reputedly the first computer to be designed with the requirements of an operating system in mind. Atlas introduced many more features including interrupts and a virtual memory system. While the idea of virtual memory took some time to make a broad impart, the interrupt mechanism made an immediate impression in computer and operating system design, since it made the job of managing several programs and peripheral devices simultaneously much easier. It made it possible for the operating system to oversee the progress of several programs and I/O activities simultaneously. In 1964, IBM produced the system 360 series of computers, which consequently evolved into system 370 and then the 303X machines in use today. This range of computers has probably been the most significant in computings history, not so much from a technological point of view, but because it provided a wide range of computing facilities within a compatible series of machines, supported by the manufacturer through many revisions and enhancements.

Single Stream Batch Processing

In order to reduce the set up time between jobs, the simple program loader concept was elaborated to allow for a continuous series of jobs to be loaded automatically from an input device (usually a card reader, but later magnetic tape). This early form of operating system was often called a supervisor, executive or monitor before the term operating system itself came into common use. However, we can see that these systems were indeed basic operating systems. The term batch processing was applied to this mode of working because jobs were submitted in batches to the computer.

Multiprogramming

Continued improvement hardware meant that the computer could cope with more work that a single batch stream could produce. The answer was- multiprogramming ! If the computer were asked to run several programs at the same time, the processor could be kept busy for most of the time by switching its attention from one program to the next in rapid succession. Additionally, I/O transfers could overlap with processor activity, i.e. while one program has to pause awaiting on I/O transfer, another program could use the processor.

In a batch multiprogramming system, a series of jobs was loaded into the memory at the same time, if sufficient memory space were available. While one job was held up waiting for an I/O transfer, another job was started. A job was selected (from those ready to run), on the basis of an operation assigned priority number. It was found advantageous to mix jobs which differed in the balance of processor to I/O activity.

Spooling

The acronym stands for simultaneous peripheral operations on-line. Essentially, this technique absorbs surplus process or time by performing I/O transfers for other jobs. Input and output date were routed via disk files so that there jobs were only required to communicate with disk systems which are, of course, much faster.

Another benefit of spooling was that access to the slow peripherals was restricted to the one program, namely the spool print program. This facilitated the sharing of devices such as printers between several running programs, avoiding the need for these programs to compete for possession of the printer. It must be remembered that the spooling operations run when no other jobs are available and hence use processor time which would otherwise be lost. While the real I/O incurred by the jobs use the much faster disk system. Overall, the thoroughput of the system was improved.

Real Time Systems

The range of applications into which computers were drawn has risen dramatically since the very earliest days of computing. A specific case in point was a class of applications referred to as real-time systems. A real time system was defined as one which responds sufficiently fast that it can influence the environment in which it was working. The term real time was usually applied to systems where the feedback is more immediate or direct, such as process control systems in factories or missile tracking systems for defence. Another valid application would be an airline seat reservation system where the availability of a seat was checked, reserved and booked where the operator is dealing with the customer. The essence of these systems was the immediacy of the interaction between the computer and the application environment. Hence, the operating systems for computes working in this fashion were to be designed to cope with the necessary speed of response. Security and safety were also of paramount importance in many of these systems.

User Interface

The user interface is the users gateway into the computer, enabling the required human-computer interaction to take place. Considering its critical nature, it is a surprise that the topic has been awarded relatively little attention in the past.

The range and diversity of computer users is such that a complete listing of distinct types would be difficult, so we will introduce here a very broad categorization which encompasses most users. They are programmers, operational and end users. Note that these categories define roles and not individuals; one person can at different times perform tasks within each of these categories. Programmers produce software, for the use of themselves or others. The software can be broadly classed as system or application. The former case refers to software such as operating systems, compilers etc, while the letter refers to Spreadsheets, Databases, Management Information Systems etc. An operational user is concerned with the provision, operation and management of computing facilities for others, possibly for other users. This would include mainframe computer operators, installation management and system engineers concerned with system efficiency, software installation etc. This would also include any person who performs housekeeping operations on a computer, such as setting up directories, deleting old files, checking on free disk space and taking backups etc. An end-user is someone who applies the software to some problem area. We can identify within this group varying levels of expertise or sophistication; at one extreme, we have the cash machine user who is perhaps unaware of his or her interaction with a computer. At the other extreme, a personal computer user could have a substantial understanding of the computer. In between these extremes, might come clerical staff using a data entry program.

There are 4 different types of user interface:-

- System calls
- Command language
- Job control language
- Graphical user interface

System Calls

To a programmer, invoking a system call is very similar in nature to calling any other procedure or function. The essential difference, however, is that in the case of a conventional subroutine, the object code is part of the calling program, while the system call code is within the operating system. An operating system will only have a limited number of available system calls and in general these will be supplemented by standard subroutine libraries. Many of these standard subroutines, which provide additional and/or higher level facilities for the programmer, will themselves use system calls. These higher level subroutines are generally organized into application programming interface or APIs.

Command Language

Command languages are designed to allow a user to interact directly with the operating system from a terminal and the principal use of the command language is to initiate the execution of the programs. Hence, it is a facility for on-line users rather than batch processors although command languages often contain some provisions for batch working.

Job Control Language

Job control languages or JCLS are used to define the requirements and parameters of work submitted to a batch system and would generally be used by computer operations staff in a mainframe environment.

Graphical User Interface

A graphical user interface or GUI (pronounced goo-ey) provide means of interacting with the system using a windows and mouse driven environment. The concept arose primarily from work done in the Palo Alto Research Centre (PARC) of the Xerox

Corporation, but was commercially exploited and popularized by Apple Corporation. When the Apple Macintosh first appeared in 1984, its (then) unique feature was that its graphical interface was its only means of interaction with the operational or end user. Since that time, many other GUIs have been developed, though usually they are layered on top of an existing command based interface, as in the case of windows for MS-DOS and X Windows for UNIX.

Scheduling

The processor at any instant can only be executing one instruction from one program but several processes can be sustained over a period of time by assigning each process to the processor at intervals, while the remainder become temporality inactive. What do we mean by the phrase assigning a process to the processor? Simply that the processor execution is directed in to the program code corresponding to the process , so that the path of execution now moves through this code. At this point, the process thus started has complete control of the processor and will continue to have this control until something happens. It is, of course, essential that the operating system regains control at some time, so that the processor can be reassigned to another process. These somethings can be either the process issues an I/O request by means of a system call or an interrupt occurs. Both of these events cause the processor execution to be diverted into the operating system, enabling it to regain control and to decide on its next cause of action. At any instant, only one process will be running while the others will be ready, waiting for the processor or in some other wait condition. The operating system has the task of determining the optimum sequence and timing of assigning processes to the processor. This activity is called scheduling.

Memory Handling by Operating System

Main memory is essential within a computer first and foremost to enable processes to exist. It is within main memory that instructions reside which are interpreted by the processor. However, in addition, to holding program code, the memory is also a work space and transient storage repository for various kinds of data. Consequently, the memory of a typical computer is occupied by a wide range of different objects such as operating system code, operating system data (process tables, file description tables etc), user program code and date etc.

Historically a number of memory management techniques have been used, and, in the process of evolution, have been superseded by superior methods. The operating systems memory manager provides the memory space to enable several processes to be executed at the same time and protect each process from each other.

In order to execute a process, the program code has to be transferred from secondary storage to main memory; this activity is called process loading.

In some systems, the reverse operation is also used, i.e. the transfer of a process from memory to secondary store. This is done in order to accommodate and consequently execute another process, the overall effect therefore being a swap of two processes; hence this activity is called swapping.

File Management

The majority of computer applications use storage facilities provided by magnetic disk and other media such as optical memory. Such systems, termed secondary storage, are used to provide non-volatile and relatively cheap storage, at the expense of access time (as compared with semi-conductor storage). In its broadest usage, the term file is applied to anything held on secondary storage. This would encompass programs (source and executable), text files such as word processing documents, saved spreadsheets and data files employed in an application such as stock control. In a narrower usage of the word, it would refer specifically to the last of these, i.e. to application data only. The view of the file data as presented to the user by the operating system necessarily hides some major complexities. Problems of physical addressing, blocking, error checking, data input/output etc are effectively masked from the user.

When a new file is created on disk, the decision as to where to locate the file, in terms of a cylinder, track and block address, has to be made. In earlier system, this was the responsibility of the user. Very often , this allocation was made with a view to optimizing performance of programs accessing the file, the file would use a contiguous area of disk, or possibly aligned vertically (ie. On the same cylinder) with another file which had to be accessed at the same time, the intention being to minimize head movement. The user was required to estimate the maximum space necessary for the file; an underestimate could cause a program to fail with an out of disk space error. This technique has given way in more recent times to numerical allocation of disk space. The operating system allocates disk space on demand by user programs. Generally space is allocated in units of a fixed size, called an allocation unit (or a cluster) which is an implement multiple of the disk physical sector size, usually 512 bytes. Typical sizes are 512, 1024 and 2048 bytes. When a file is first created, it consists solely of one cluster. Note that this is the minimum space assigned to a file, been though it consists only of a few bytes. As the file is extended by the appending of more data, eventually the cluster will be filled. More clusters are assigned to the file as the need arises. Clusters can be released as well as assigned to files. This would happen if the file were deleted or simply contracted in size.

Security Techniques

The operating system can significantly contribute to the security of the resources of a computer. Operating system can provide security in many ways like passwords, access control, encryption, etc.

A password mechanism is often the first and most significant line of defence in a multi-user system. In order to gain access to the system, the user enters an personal identification name together with a password associated with that ID name. The password can be assigned by an administrator or devised by the individual user. In principle, the password technique ought to provide a satisfactory level of security against unauthorized access to the system, but in practice it has been found on occasions to be suspect. The main problem associated with passwords is that users tend to use easily remembered words which consequently are more readily guessed by a potential hacker. File access control is another level of security in which operating systems generally include facilities for the protection of files. Encryption is the conversion of data in some intelligible format into an unintelligible format to prevent the data from being understood if read by an unauthorized party. A reverse operation, decryption, converts the encrypted data back to its original form.

A BRIEF HISTORY OF LINUX

Linux is not strictly speaking a UNIX system, since it doesn't contain any of the licensed code of real unix systems, but has been designed from scratch as a look alike and placed in the public domain. It is strongly POSIX-based, ensuring compatibility with POSIX-compliant systems. It can run an a number of different platforms, but possible its most important aspect is that it can be used on a PC.

Although many people might refer to Linux as the operating system and included software, strictly speaking, Linux is the operating system kernel, which comes with a distribution of software. Linux was first released in 1991 by its author Linux Tovvalds at the University of Helsinki. Since then it has grown tremendously in popularity as programmers around the world embraced his project of building a free operating system, adding features and fixing problems. Linux is popular with today's generation of computer users for the same reasons. Early versions of the unix operating system enticed fans more than 20 years ago. Linux is portable, which means you'll find versions running on name-brand or alone PCs, Apple Macintoshes, Sun workstations or Digital Equipment Corporation Alpha based computers. Linux also comes with source code, so you can change or customize the software to adapt to your needs. Finally, Linux is a great operating system, rich in features adopted from other versions of Unix.

A BRIEF HISTORY OF MS-DOS

In 1979, a small company called Seattle Computer Products, which manufactured memory boards, decide to write its own operating software to test some of its Intel based products. This system, called 86-Dos, was bought by IBM. IBM then enlisted the help of Microsoft to develop it into a commercial product. The IBM PC was announced in August 1981, with version 1.0 of MS-DOS, referred to by IBM as simply DOS and later as PC-DOS. In 1983, version 2.0 of MS-DOS appeared, which was a major advance in design of the system version 2.0 was designed to meet the needs of a newly- announced IBM computer, the PC/XT, which had a built-in 10mb hard disk. To simplify management of this vast storage, version 2.0 introduced a hierarchical file directory structure based on the unix model.

A BRIEF HISTORY OF WINDOWS SYSTEM

There are essentially three main types of Microsoft Window Systems: Original MS-DOS based version, Windows 95, Windows NT.

The MS-DOS based version was layered on top of MS-DOS, which primarily provided support for the disk system development of this line terminated at version 3.11. Windows 95 was derived from the original windows but is base on 32 bit code (mostly).

It is intended as the natural successor to Windows 3.11 for personal and smell system use. It provides pre-emptive scheduling, 32 bit addressing with memory protection and has a graphical user interface distinct from version 3.11. While being independent of MS-DOS, MS-DOS applications are executed directly using modified MS-DOS code and hence can execute any programs written
for MS-DOS. The latest of them is Windows 98. Microsoft came out with an Operating System for network called as Windows NT. Windows NT was designed as a completely new product. Windows NT has built-in provision for net working.

REVISION EXERCISES

1. Write a short note on the history and evolution of operating system.
2. "User Interface with the computer is not complete without an operating system". Do you agree with the statement. Give reasons.
3. Explain the concept of Single Stream Batch Processing.
4. What are the benefits obtained by the user from the spooling technique.
5. How does the user interface make the human-computer interface a smooth interaction?
6. What are the different types of user interfaces? Highlight the differences between them.
7. Explain briefly the term scheduling.
8. Write a short note on memory handing by the operating system?
9. How is a file structure managed by the computer's operating system?
10. Briefly explain the security techniques in an operating system.
11. Give a brief history on:
    (a) Linux
    (b) MS-DOS
    (c) Windows System

Chapter 10:
DOS: DISK OPERATING SYSTEM

DOS was developed by Microsoft primarily as a single user operating system working on Personal Computers. From 1981 till now many versions starting from Ver 1.0 till 6.2 have been released. Each successive version had its enhancements aimed at improving the management of the computer resources available to the users.

As has been explained earlier it is essential for the operating system programs to be resident in the memory of the computer. The process of loading these programs into the memory is termed as Booting the computer. In DOS these programs are MSDOS.SYS, IO.SYS and COMMAND.COM. However MSDOS.SYS and IO.SYS are hidden programs and cannot be seen in the Directory listing.

Loading of these programs is done either by inserting the systems floppy (the floppy containing the above three programs) in the floppy drive and switching on the computer. The loader program resident in the ROM reads these programs and loads all the instructions in the memory. The screen of the monitor displays the A prompt (A:\>), thereby signalling to the user that the computer is ready to be used.

Alternatively, if the system is not available, the computer can be booted from the hard disk.

The only difference is that the screen will now show the C prompt (C:\>) instead of the A prompt.

In order to load the DOS files from Floppy to Hard Disk the following command is used:

A:> SYS A: C:

If one needs to make a system Floppy from the Hard Disk the DOS command used is:

C:> SYS C: A:

DIRECTORIES

In the DOS environment, each disk is organised into directories. Each Directory holds files. The default directory is the Root Directory and contains the minimum DOS Files. The Root Directory has no name in the DOS terminology.

The Root Directory cannot show more than 132 files in its directory listing.

Todays computing environment consists of using various computer languages and packages in order to satisfy our computing needs. If all these packages, languages and associated data, program files etc. are kept together in the same directory, file managing and handling becomes extremely inefficient. In order to tackle this inefficiency, DOS allows users to create subdirectories within the Root Directory and within subdirectories as well.

Commands to Create a Directory

In order to create a directory named DEEP in the Root Directory, type in the following command:

C:\> MD\DEEP

or type

C:\>MKDIR\DEEP

Changing Your Working Directory

In order to work with files in the directory DEEP type the following command:

C:\>CD\DEEP

Removing a Directory

To remove a directory, please ensure that the directory is empty and enter the command:

C:\>RD\DEEP

The DIR Command

This command enables us to view the contents of a directory.

C:\>DIR – This gives a complete listing of files and directories.

C:\>DIR/P - This command pauses the directory listing at every screen.

C:\>DIR/W - This command shows the listing width-wise on the screen.

FILES

The most common requirement of a computer user are commands to manage his files.DOS has a naming convention for all files which states that:

Files can have names upto 8 characters. This can be followed by a (.)dot and an extension of upto 3 characters. However, special characters like commas, slashes, blanks etc. are not allowed in a file name. Hence

MYFILE is a valid file name.

MYFILE.BAK is a valid file name.

MY FILE is invalid because a blank space has been given.

MY,FILE is invalid because of the comma.

Creating a File Using Editor

DOS has an inbuilt editor which allows you to create a file.In order to create a file named ANYFILE enter the command

C:\DOS> EDIT ANYFILE

Figure 10.1

DOS will present a screen as shown above. You can then enter your program or text in the box and exit out of the editor by using the ALT+F key and then press X.

Commands to Copy Files

C:\>COPY ANYFILE A: (This command will copy the file named ANYFILE in the Root Directory to a Floppy)

C:\>COPY ANYFILE \DEEP (This command will copy the file ANYFILE from the Root Directory to the DEEP directory.)

WILD CARDS

DOS supports two wild cards '?' and '*', which allow you to specify whole groups of file names. The '?' stands for any single character in their specified position within the file name and the '*' stands for any set of characters, starting at the specified position within the name and extension and continuing till the end of the filename or extension.

For example, DIR A:??001.* will list all files having any character values in the first two position of the filename followed by 001 and any three characters in the extension.

C\:> COPY *.* A: COMMAND will copy all files in the Root Directory on to a floppy.

THE ATTRIB COMMAND

C:\> ATTRIB –R ANYFILE : This command is used for making your file ANYFILE as read and write, i.e. you can both read as well as write from and to the file.

The following notations can be used with the ATTRIB command:

+R	:	Makes the file read only
+H	:	Suppresses the file in the directory listing, i.e. makes it hidden
-H	:	Unhides the previously hidden file
+A	:	Changes file settings to Archived
-A	:	Changes file settings to Not archived
+S	:	Marks file as DOS system file
-S	:	Removes DOS system file setting

RENAMING A FILE

C:\>RENAME ANYFILE MYFILE

This command allows us to rename the file named ANYFILE to MYFILE.

DELETING A FILE

C:\> DEL ANYFILE

The above command will delete the file named ANYFILE.

Erase can also be used to delete files.

THE DELTREE COMMAND

If you wish to remove unwanted directories and their contents (files and subdirectories) use the DELTREE command.

C:\>DELTREE C:\deep

PRINTING ON SCREEN

C:\>TYPE ANYFILE

This command will output the contents of the file ANYFILE on the screen. However, it will pause at the end of the text. As a result, you will not be able to view the total contents. In order to view screen by screen, use the Piping feature of DOS.

Piping

If you desire to reprocess the output obtained from a DOS command by another DOS command then one way to do this is to redirect the output to a disk file and then send the contents of the file as input to the next command.

However, DOS allows you a more convenient method in which you can combine multiple commands on a single line. This technique is called piping and uses the pipe character | to combine the DOS commands.

For instance, in the previous example if we wished to pause at every screen to view our output, we would enter the following command:

C:\> TYPE ANYFILE| MORE

MORE forces DOS to display output one screen at a time.

REDIRECTION OPTIONS IN DOS

Output can be redirected to various devices by using the > symbol for output and < symbol for input.

Standard target device names are as under:

CON	The screen or console
PRN	The default printing device
LPT1	Parallel printer port
COM1	Communication serial port 1
COM2	Communication serial port 2
AUX	Auxiliary output device
NUL	Null device (Suppresses output from device)

C:\> TYPE MYFILE >PRN

The above command will redirect output of the screen to the printer.

SOME DISC COMMANDS

The Format Command

Formatting or initializing floppy or disk is the technique of creating tracks and sectors on the floppy which are ultimately used for reading and writing data from and to the floppy. The command provided by DOS for this important task is as follows:

C:\> FORMAT A: Formats the floppy in drive A.

C:\> FORMAT A:/S Formats the floppy and also transfers the systems files to the floppy.

The Scandisk Command

C:\>SCANDISK /ALL

This command available in DOS 6.2 version analyses and repairs logical and physical disk errors. If DOS version is lower than 6.2 use CHKDISK/F command instead.

THE CONFIG.SYS FILE

This is a user defined file in DOS and contains additional information for the operating system regarding the environment in which the user desires to work. For instance a config.sys file may contain the following DOS commands:

DEVICE=\DOS\HIMEM.SYS

FILES=100

BUFFERS=40

DOS=HIGH

The device command tells DOS to look for extended memory. DOS would, by default, assume that your computer has the primary conventional memory of 640 KB only. However, HIMEM.SYS will check for extra memory.

The FILES command tells DOS that upto 100 files can be open at a given point of time. Otherwise the default of 8 files is applied by DOS.

DOS=HIGH tells DOS to load the operating system files in upper memory area leaving the conventional memory area free for applications which require more of conventional memory.

When the computer is booted, the operating system first reads the CONFIG.SYS file in order to configure the environment before bringing up the C prompt.

THE AUTOEXEC.BAT FILE

This is also a user defined file, which contains DOS commands to be executed before the user actually starts his session on the computer. For instance, if the user desires that the computer should check for any viruses on his hard disk the following command should be written in the AUTOEXEC.BAT file.

MSAV C:

We have so far discussed some of the very common and necessary commands and files of the disk operating system which must have given you an idea of the DOS environment & which must have illustrated some important features of DOS. We shall now discuss the commands.

COMMANDS IN DOS

DOS commands can be divided into two categories:

1. Internal commands: Internal commands are those commands that can be entered once the DOS prompt is available, i.e., they do not need any special files for their execution. For example

   A:/> CD\DOS

   is an internal command that changes the directory.

2. External commands: External commands are those commands that need separate files, containing their source codes, to invoke them. The external commands basically are accessories to the operating system that increase its extensibility.

A:/DOS > FORMAT C:

The above command would format the drive C:. The file FORMAT.EXE should be present in the DOS directly of drive A: for the command to be executed as desired.

Given below are some of the common commands with their function and syntax.

Break

Type: Internal command.

Function: When the 'BREAK' command is invoked, (i.e., BREAK ON), the computer checks to see if Ctrl.C would stop the execution of the current DOS command.

Syntax: BREAK ON or OFF.

CD

Type: Internal command.

Function: The CD command is used to the change the directories which may be on the same or other drives.

Syntax: CD drive:\path.

CHKDSK

Type: External Command.

Function: The CHKDSK command analyses, diagnoses and optionally corrects comman hard disk errors. CHKDSK can also be made to work on a specific file to check whether it is contiguous (stored in adjacent areas of the disk) or noncontiguous (scattered over separate areas of the disk).

Syntax: CHKDSK drive:\path\file\switches.

CLS

Type: Internal command

Function: The CLS command clears the screen and only the operating system prompt on the top left corner is displayed.

Syntax: CLS

Copy

Type: Internal command

Function: As the name suggests the COPY command is used to copy files from one destination to another.

Syntax: COPY source_drive:\path\file(s) target_drive:\path\file(s).

CTTY

Type: Internal command

Function: The CTTY command redirects a console input or output to a distant input/output device (eg. printer).

Syntax: CTTY device-name.

Suppose the device is the printer connected to LPT1. The appropriate command would be.

CTTY LPT1

Date

Type: Internal command.

Function: If the DATE command is used without any parameters, DOS displays the current system date & prompts the user to enter another. If after the DATE command, the date is included, DOS changes the date.

Syntax: DATE date.

DBLSPACE

Type: External commands.

Function: The DBLSPACE command is used to compress the data files. It can also be used to compress the entire drive. The DBLSPACE has very vast applications which are beyond the scope of this book.

Syntax: DBLSPACE/Switches drive:

DEFRAG

Type: External command.

Function: The DEFRAG command is used to arrange the files in contiguous sectors. Files become fragmented over a period of time. Hence, the DEFRAG command should be perodically used to increase the performance of the system

Syntax: DEFRAG drive:/Swithces.

DEL (ERASE)

Type: Internal command.

Function: The DEL command is used to delete files.

Syntax: DEL drive\path\file(s)/switches

ERASE drive:\path\file(s)/switches

DELTREE

Type: External command.

Function: the DELTREE command is used to remove an unwanted directory, plus all files on it, and all subdirectories nested below it, in a single command.

Syntax: DELTREE/switch drive:\path.

DIR

Type: Internal command.

Function: The DIR command displays a list of files in a directory. The DIR command without parameters displays the list of files in the currently logged drive and subdirectory.

Syntax: DIR drive:\path\file(s)/switches.

DISKCOMP

Type: External command

Function: The DISKCOMP command compares the contents of two floppy disks on a track to track basis, reporting which track numbers are not identical.

Syntax: DISCOMP source; target:/switches.

DIScopy

Type: External command

Function: The DISCOPY command copies the contents of one floppy disk to another on a track to track basis.

Syntax: DISCOPY source: target:/switches.

DOSHELP

Type: External command

Function: The DOSHELP command provides instant help to the user when invoked.

Sytax: DOSHELP Command

or

Command /?

When executed instant help is provided on the 'Command Name' entered.

DOSkey

Type: External Command.

Function: Once invoked the DOSKEY command introduces a special buffer space in which the DOS commands being entered are stored. Each time a command is entered it is added to the DOSKEY's Command buffer. These commands can be recalled.

Syntax: DOSKEY.

EDIT

Type: External Command.

Function: The EDIT command provides a text editor for the editing of text files or batch files.

Syntax: EDIT drive:\path\file/switches.

FC

Type: External command

Function: The FC command matches the contents of two files or sets of files and reports the differences between them.

Syntax: FC/switches drive:\path\file(s) drive:\path\file(s)

FDISK

Type: External Command.

Function: The FDISK command is used to partition the hard disk. This command should be used on a formatted hard disk, otherwise it may erase or overwrite the existing files.

Syntax: FDISK/switch.

Find

Type: External Command.

Function: The FIND command is used to find all occurrences of a specified character string in a file. This command is case-sensitive, i.e., it distinguishes between upper case and lowercase letters.

Syntax: FIND/switches "string" drive:\path\file.

FORMAT

Type: External Command.

Function: The FORMAT command prepares a blank disk for storing, or creates a new blank disk from a used one. In other words, the disk is formatted.

Syntax: FORMAT targetdrive:/switches.

HELP

Type: External Command.

Function: The HELP command is synonmous to the DOSHELP command. It displays the syntax summary of the command name entered.

Syntax: HELP Command.

KEYB

Type: External Command.

Function: This command when invoked loads a non-standard keyboard configuration into memory.

Syntax: KEYB keyboard codepage drive:\path\library file.

The Library file usually is KEYBOARD.SYS

LABEL

Type: Internal Command.

Function: Every disk has the option of having a volume label which can be used for its identification. The LABEL command adds or modifies the volume label.

Syntax: LABEL target: Labelname.

MD

Type: Internal Command.

Function: The MD command is used for creating a new directory or subdirectory.

Syntax: MD drive:\path directoryname.

MK DIR can also be used in place of MD.

MEM

Type: External Command.

Function: The MEM command displays the information on the allocation of the random access memory.

Syntax: MEM/switches.

MORE

Type: Internal Command.

Function: The MORE command when used displays the output one screen at a time instead of continuous scrolling. The MORE command is used to display the contents of a data file or to display the coutput of a program.

Syntax: MORE < drive:\path\file(s)

or

Command (parameters) | MORE

For eg.,

MORE < STUDENT.TEXT

or

TYPE STUDENT.TXT | MORE

Move

Type: Internal Command.

Function: The Move Command Moves files from one location to another. This command is quite identical to the copy command the only difference being that the source files remain intact in the case of the copy command while they are delated in the case of the Move command.

Syntax: Move Source:\path\file(s) target:\ path\file(s)

MSAV

Type: External Command.

Function: The MSAV (Microsoft anti-virus) command scans the memory for the presence of computer viruses.

Syntax: MSAV drive:\path\switches

NLSFUNC

Type: External Command

Function: The NLSFUNC command when invoked loads national language support functions which allows the user to switch to international character set tables in RAM.

Syntax: NLSFUNC drive:\path\country file

PATH

Type: Internal Command

Function: The path command searches in a list of subdirctories (specified in its syntax) for executable program files.

Syntax: PATH drive:\path1; drive\path2

For Example,

PATH C:\DIR1 ; C:\DIR2

would look for all executable files on DIR1 & DIR2 subdirectories.

PROMPT

Type: Internal Command

Function: The PROMT Command is used to change the appearance of the Dos prompt.

Syntax: PROMPT prompt starting

The prompt may one or a combination of the following.

$ $	Dollar Sign ($)
Sb	Piping Symbol (I)
$d	Current date
$g	Greater than symbol (>)
$\	Less than symbol (<)
$q	Equel sign (=)
$t	Current time
$v	DOS version number
$p	Currently logged drive and directory
$n	Current drive
$e	Escape character

RD

Type: Internal Command

Function: The RD Command is used to remove directories. The directory to be removed should be empty.

Syntax: N drive:\path\country file

RMDIR can also be used in place of RD.

Rename or REN

Type: Internal Command.

Function: The REN command is used to change the file names.

Syntax: REN drive:\path\oldfilename drive:\ path\newfilname

RENAME can be used in place of REN.

Replace

Type: External Command.

Function: The REPLACE command is used to replace and files with new files of the same name. This command is used update data files.

Syntax: REPLACE source:\path\file(s) target: \path\switches.

The above statement replaces the files in the target directory with that of the source directory.

Sort

Type: Internal Command.

Function: The SORT command sorts data in character based files or sorts the output of DOS commands.

Syntax: SORT/Switches < drive:\path\file.

or

Command : SORT/Switches.

for eg.

TYPE STUDENT.TEXT : SORT

TIME

Type: Internal Command.

Function: The TIME command us used to display or change the system time.

Syntax: TIME (displays the current system time)

TIME hh:mm:ss a/p

a & p stand for a.m. or p.m.

TREE

Type: Internal Command.

Function: The TREE command displays the subdirectory structure of a drive.

Syntax: TREE drive:\path/switches.

TYPE

Type: Internal Command.

Function: The TYPE command displays the contents of a file.

Syntax: TYPE drive:\path\file

The following statement.

TYPE STUDENT.TXT > PRN directs the output to the printer.

UNDELETE

Type: External Command.

Function: As the name suggests the UNDELETE command is used to UNDLETE files that have previously is not always successful in recovering the deleted files. A file may be undeleted if the disk area it occupied has not been overwritten by another file.

Syntax: UNDELETE drive:\path\file(s) /Switches

UNFORMATED

Type: External Command.

Function: The UNFORMAT command is used to recover files which were lost when the disk was formatted.

Syntax: UNFORMAT drive:/swithces.

VER

Type: Internal Command.

Function: The VER command displays the version number of DOS.

Syntax: VER.

VOL

Type: Internal Command.

Function: The VOL command displays the volume label of the disk.

Syntax: VOL drive

Not all the commands have been covered, due to the scope of the book. We have tried to cover the most commonly used commands.

REVIEW EXERCISES

Multiple Choice Questions

1. Which of the following commands is correct if we wish to copy a file named ANYFILE in the root directory to a directory named MYDIRECT?

   i. C:\> Copy anyfile mydirect

ii. C:\>copy anyfile \mydirect

iii. C:\>copy \mydirect anyfile

iv. C:\>copy anyfile /mydirect

2. Formatting of a floppy disk is done by

i. physically cutting tracks & sectors

ii. logically dividing the surface into tracks and sectors through software

iii. the manufacturer of the floppy

iv. copying the system files

3. The CONFIG.SYS file is

   i. a user made file

   ii. a system file

   iii. a file containing application program

   iv. none of these

4. Bootstrapping is

   i. the process of loading the OS programs

   ii. the process of loading OS into the RAM programs into Hard Disk

   iii. the process of copying OS to floppy

   iv. none of these

5. Mark True or False

   i. Renaming a file named ANYFILE to MYFILE can be done by the command COPY ANYFILE MYFILE.

   ii. Deleting a file named ANYFILE can be done by the command DEL ANYFILE.

   iii. The command C:\>Copy *.* A: may not be able to copy all the files in the hard disk if the files in the hard disk occupy more than 1.44 MB.

   iv. DOS always assumes that your computer has 640 KB of memory unless and until you tell DOS otherwise.

   v. DOS is a multi-user operating system.

   vi. The SCANDISK command checks your computer for viruses.

   vii. Piping is the technique of using the output of a DOS command as the input of another DOS command.

   viii. Output redirection to PRN is the only way to print a document in DOS.

Chapter 11: FEATURES OF THE UNIX OPERATING SYSTEM

SALIENT FEATURES

The Unix operating system offers many features. Some of these important features are discussed below:

Multi-tasking Capability

This capability allows the operating system to perform several tasks simultaneously. For instance, Unix can print one document, edit another and sort a list of files at the same time. Multiple tasks can be carried out by placing other tasks in the background while you work on one task at a time. The current tasks are said to be in the foreground. Normally the tasks that do not require active interaction from the user are placed in the background. The more tasks are run in the background, the lower will be the system response.

Multi-user Capability

Multi-user operational system permits several users to use the same computer to carry out their job. Several terminals are connected to a single powerful computer and each user of the terminal can be a programmer, program access files and prints document at the same time. Need for the multi-user environment arises when several programmers work on developing module of the same software. Multi-user environment ensures complete coordination and compatibility and saves a considerable amount of time by allowing several users on a set of information at a time. Buying single multi-user computer is far more economical and efficient than buying several single users computers.

System Portability

The Unix operating system can port itself to another installation without any major changes. This ability to adapt itself to different computers has made Unix very popular. Unix runs on more brands of computers than any other operating system.

Communications

Unix supports two major types of communication:

(i) Communication between different terminals connected to the same computer.

(ii) Communication between users of one computer at a specific location to the users of another type and size of a computer located elsewhere. The two computers may be located in different offices or different countries or continents. These type of communication is achieved by a mail system based on wide area and may be connected through telephone lines or satellites.

System Security

The user data is highly secure in the Unix operation system. There are several levels of security in Unix. The first level is system security. The standard login procedure before Unix starts running on the system ensures that not just anybody can start running Unix on your system.

The next level of security is incorporated when it comes to accessing files. Three permission namely, read, write and execute can be assigned by the owners of file to each of his files. All these permissions can be individually cancelled or denied to all other users of the system.

The third level of security allows users to encrypt data files on the disk so that even if someone does manage to access them he cannot make much sense of it.

THE UNIX CONNECTIONS

Unix being a multi-user operating system, has to support a large number of users without any bias. This means that Unix has to make the right connections using the right priorities and right links.

At the heart of the Unix installation is the host machine. This is the powerful computer that can support many terminals. The number of terminals being supported is limited by the hardware used and resources available in the host machine. Users are connected to the host and are provided with terminals to work on. These terminals consist of a keyboard, display along with the associated hardware such as ports and cables. A terminal may be connected to the host either directly or through telephone lines. There are different types of terminals and modes of connected to the host also differ. A few types of terminals that users of Unix often use are:

Dumb Terminals: These terminals consist of minimum components that every terminal must possess – a keyboard and a display.

Intelligent Terminals: These terminals have a mind of their own. They have their own memory and a few enhanced features. Yet all the processing and execution of programs is carried out only in the host machine.

Terminal Emulation: Terminal emulation allows a PC to act as a terminal. In this case, in spite of having a microprocessor the PC performs no processing at all. It transmits its processing jobs to the host computer. This PC can be used as a stand-alone computer once the Unix session has ended.

Dial-in Terminals: These terminals use telephone lines to communicate with the host.

The Console: The console is connected directly to the host. Every Unix installation has only one console which is used by the System Administrator, in order to administer the system.

LOGGING INTO THE SYSTEM

In the Unix operating system, the booting or the startup procedure which is explained in detail in this module can be done only at the console. No other terminal can be used until the console is started.

After switching on your computer (the console), you encounter a 'Login' prompt on the screen which is followed by 'password' prompt.

Login

The purpose of this prompt is to identify the user and allow access to the system only after verifying the identity of the user. The login prompt requests the user for a name or an "id" which is given to the user by the system administrator. After entering the login name the system further requests for a password.

Password

The prompt requires the user to key in the password that he has been assigned or he has selected. The password is not echoed on the screen to protect the privacy of the user. If the user fails at this stage the Unix session never takes off. The login name and password should always be entered in lower case because Unix is case sensitive. All the Unix commands are in lower case.

COMPONENTS OF THE UNIX OPERATING SYSTEM

The Unix operating system is functionally classified into the following components:

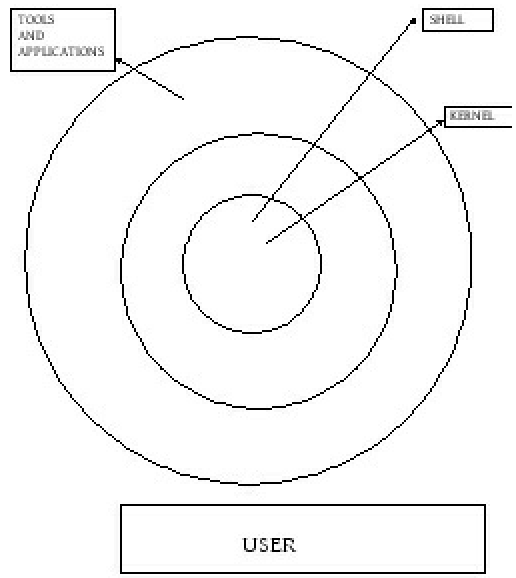


Figure 11.1: Components of a Unix Operating System

The Kernel

It is the core or skeleton operating system program. It performs all the low-level jobs necessary to control all the tasks and hardware devices, schedule all the processes and carries out all the crucial functions of the operating system. All operating systems have a kernel that contains many routines to carry many tasks that the operating system has to handle.

Utility programs written as software tools perform all other typical operating system functions. Use of software tools, instead of a single large operating system program distinguishes Unix from other operating systems. What makes the kernel utility structure work is the interface to the kernel called the SYSTEM CALL INTERFACE.

A system call is call to an operating system service routine used in the kernel. This call can be made in "C" or Assembly Language program. When you make a system call, the portion of kernel with the relevant programming is run. The system calls are the basic building blocks upon which Unix commands are based.

The Shell

It is the command interpreter of the operating system. It accept commands from the user at the "$" prompt and analyses and interprets these commands. All Unix commands are executable C programs. The shell starts executing the appropriate executable file and then requests the kernel to carry out the data transfer which finally leads to the output that is displayed on the terminal. Hence the shell acts as the middleman between the kernel and the user of the operating system.

UNIX TOOLS AND APPLICATIONS

The outermost layer of the Unix operating system is its Tools and Applications. Tools vary from one implementation of Unix to another. Some versions of Unix are decked with more than 400 tools.

These tools can be involved from the command line itself and help to perform day-to-day as well as complex tasks of the system. Unlike shell and kernel these tools are not mandatory. Tools on the other hand, are programs which are not necessary for the computers basic operation, but provide significant additional value to Unix when available. These tools include many application programs, which may be purchased separately, such as electronic spreadsheet and sophisticated word processing packages.

PROCESS

In Unix, each particular task or program that the kernel is currently undertaking is called a process. A process in short is a running program. For example if you are running the date command, it is one process. If it is run again, it is a new process.

THE UNIX SCHEDULER

The scheduler is a program in the kernel that allows more than one person to use the computer at the same time. It shares the computer resources among various users, allowing each a small slice of the computer's processor. This concept is known as Time-Sharing.

Let us consider the example of a hotel bearer to understand the concept of Time-Sharing. Every Hotel Bearer is assigned the job of serving a section, which comprises of a certain number of tables. The bearer cannot practically handle all the tables at the same time. He instead concentrates on only one party at a time. He task orders from a party seated at a table, then moves to another and so on. He thus allots a time slice for each table in his section. When it comes to serving, first on the priority list is the party, which had placed its order first. Thus time slots are allotted for serving different tables. Every party is thus given an impression of being the only party being served, because the bearer is available when the need arises.

Similarly, if three people want to run different programs a, b and c, the scheduler copies these three programs from the disk and stores them in the computer memory. These programs are now referred to as processes. In this way, program is defined as a file, which resides on the hard disk, where as a process resides in memory doing things.

The scheduler allows process "a" to run for a fraction of a second and do a little work that it was designed to. After this time slice is over, process "a" is temporarily stopped or suspended, and process "b" is allowed to run. When the time slice of process "b" is exhausted, process "c" gets its chance to run.

When each process has had a chance to run for a while, the scheduler comes back to process "a" and starts "a" where it left off when it was suspended at the end of its time slice. The Unix scheduler can keep track of several hundred processes.

The overall effect of timesharing is to give users the impression that they all are being served at the same time.

Round Robin Scheduling

Every scheduling uses a different Scheduling Algorithm. One of the oldest, fairest and most widely used algorithms is Round Robin. In this algorithm, each process is assigned a time interval, called its quantum, which is allowed to run. If the process is still running at the end of the quantum, the CPU is preempted and given to another process. If the process has blocked or finished before the quantum has elapsed, the CPU switching is done. All the scheduler needs to do is to maintain a list of runnable processes. When the quantum runs out on a process, it is put on the end of a list.

Swapping

The simple model of scheduling works fine for a few process but sooner or later, all the computers' memory gets filled with running processes. At this point, if the user wants to run a process, there must be a way out. It is here that the concept of swapping comes into picture. In swapping, when memory is full and a new program needs to be run, the scheduler copies a process from memory to disk and thus creates space in the memory for a new process. It then places a new program in memory and allows it to run. Later, the process is copied back to the disk and the process on the disk is copies back into memory.

For instance, say there are three processes A, B and C in the memory. Now a request is made by a user to run program D. Since there is no space in the memory for process D, process A is copied to the disk. After A is copied to the disk, a copy of D is then put is memory where A resided. After a few time slices, the scheduler will again exchange process *A* with the process that has been in memory the longest.

DIFFERENT SHELLS USED IN UNIX

There are four shells in Unix out of which three are commonly used:

The Bourne Shell

It is most widely used shell in the Unix world. It was developed by Steve Bourne of AT & T Bell Laboratories in the late 1970's. It is a primary Unix command interpreter and comes with every Unix system. The "$" prompt on the Unix installations is a trademark of the Bourne Shell.

The C Shell

Bill Joy created this shell at the University of California at Berkeley. The C shell is the default shell in the Berkeley version of Unix.

The Korn Shell

This shell was developed by David Korn of AT & T and was designed to be much bigger than the Bourne Shell. It includes all the enhancements available in the C shell and offers a few more features which make it more versatile and efficient. It can completely replace the Bourne Shell in a system.

The Restricted Shell

This shell is almost the same as the regular shell but it is designed to restrict the user's capabilities by disallowing certain actions that the standard shell allows.

ENTERING A COMMAND

The appearance of a "$" prompt in Bourne Shell and a "%" prompt in C shell is an indication to the user that he can now type in his commands. A command typed at the shell prompt asks the Unix system to do something. Let's start with some simple commands:

date

This command tells the Unix system to print the system date and time. Every Unix command must be ended with a RETURN. RETURN informs the system that the user has finished typing in.

who

This command can be used to get information about all users who are currently logged onto the system.

echo

This is a very simple and straightforward command. It displays on the screen whatever is typed after the command echo on the command line.

ps

The ps command makes a process status report. Try typing ps at the $ prompt. You will get an output that looks something like this :

PID	TTY	TIME	COMMAND
[illegible]	13	0:12	SH
2376	12	[illegible]	PS

The first column is the process identification number, PID. Each time a process is initiated the kernel assigns it a unique PID. This is how the kernel keeps track of different processes. In our example the only two processes are – the shell itself (sh) and the ps command. The sh process in this example is called the parent, and the ps process spawned by the shell is the child. In the Unix world, a process is said to be "born" when it starts executing and "dead" when it terminates. A new process can be born only if another process starts it. The new process is called a "child" and the process that starts it is called the "parent". You can start up a new shell by typing the command sh at the $ prompt. The TTY column identifies the terminal or other input device that you are using. The TIME column tells how much computer time the process has used so far. The command column gives the name of the command corresponding to the process.

clear

This command will clear the screen and leave no trace of the command you just typed.

THE UNIX FILE SYSTEM

A file system in its simplest form is a collection of files stored on a storage device like a disk. Whenever data is to be stored onto the disk it is recorded on a particular section of the disk, in a predefined format. It is the operating system which takes care of recording files. Generally operating systems have their own ways of organizing data for storage. Before a file system can be formed on a disk, the disk storage is logically divided into smaller units like sectors or blocks. The first few blocks within a file system are used as system blocks or the area is called as system area. This area is mainly used by the host operating system to record the information about the file system, which is updated from time to time whenever any manipulations are done with the files of the file system. The rest of the block storage is used as data area, where the files are stored.

Multiple File Systems

A single disk system may have the disk partitioned into subsections, each subsection (or partition) housing a file system.

The entire Unix set of system files which include, the operating system, system utilities and system accounting programs etc. use these file system unit called root file system. Apart from root file systems, some user file systems can be created on the disk. One such file system is created during UNIX installation, which is called user. This file system is used to house user files, utilities and libraries etc.

Additional user file systems can also be created, as per the users' requirement. In that case for every file system a new portion will have to be assigned on the disk at the time of installation. A user can even create file systems on portable disks like floppies.

Before a file system can be used for any operations, it should be Mounted. Mounting involves reading of the system area of that particular file system into the memory. After successful mounting, a file system is treated as a directory. The root file system is mounted at the time of system start up. All the other file systems are treated as sub-directories under the root directory after being mounted.

Visiting a Typical File System

The Unix file system has the following structure:

The System Area:

- Boot block
- Super block
- Inode block

The Data Area:

- Data blocks

(1) The Boot block: This block occupies the beginning of a file system, typically the first block and contains the boot strap program that is read into the memory during booting. The main job of bootstrap program is to load operating system program (Unix) from the disk. Every file system has a boot block, but it is only used in the root file system. In other file systems this block remains empty, reason being that the ROM – BIOS system start up routine looks for the boot strap program only in the boot block of root file system.

(2) The Super block: The super block follows the boot block. This block contains

information about that particular file system. This information comprises of:

- The size of the File System.
- The size of the i-list section of the file system which follows the super block.
- The number of unallocated blocks in the data portion of the file system which follows the i-list.
- The block number of the unallocated blocks.
- The last time the super block was written to the disk.
- The file system type that tells the size of the logical block in the file system.

(3) The Inode blocks: The super block is followed by the inode block. Each inode block is an array of inode numbers, where each inode defines the properties of a file. The system administrator specifies the size of inode list when configuring a file system. The information in the inode is stored in given format.

(4) The Data block: They start at the end of the inode list and contain file data and administrative data. An allocated data block can belong to one and only one file in the file system. The block which are not yet allocated to files also are present here.

The Unix file system is a device independent structure that resembles an upside down rooted tree, made from the following types of files:

Ordinary Files

These files contain information stored in some format.

Directory Files

Directory files are modes that tie the file system together. Every file in the Unix file system is assigned to a directory.

Fifo Files

These are files that allow unrelated processes to communicate with each other. Fifo files are typically used in applications where the communication path is only in one direction and where several processes need to communicate with a single process. Each process writes a message to the fifo file and the Unix system guarantees that each individual message will not be overwritten by messages from other processes.

Special Files

Special files represent physical devices. Every device connected to the computer, for example, a printer or a terminal is treated as a file. When the process writes to a special file, the data written is sent to the associated physical device. Likewise, when process reads from a special file, the data is read from the associated device and returned to the process.

THE HIERARCHICAL FILE SYSTEM OF UNIX

The Unix file system begins with a directory called "root". The root directory is denoted by a slash (/). From the root originate several directories namely "bin", "etc", "usr", "dev", "lib", "tmp" and an ordinary file named "Unix" which is the kernel program itself. This is the file which is loaded into memory during system startup.

These directories are called subdirectories of the root and conversely the root directory is called the "parent" directory of these directories. Each subdirectory in turn can contain other directories and files, which give rise to the branching, upside down tree structure.

/root :

/bin /etc /dev /usr /lib /temp

Each subdirectory of the root in the Unix file system is assigned a particular task:

/ : The root directory where all other directories originate.

/dev : All the device files are kept in this directory.

/bin : The "bin" directory contains the executable files for most Unix.

/etc : It contains a mixture of files and subdirectories. The list of users and groups plus a description of each terminal is in this directory.

/lib : The "lib" directory consists of the libraries provided by Unix for programmers.

/usr : The "usr" directory contains subdirectory in which the user work area is provided.

/tmp : The "tmp" directory is the temporary directory in which most of the temporary files are kept. Files stored in this directory are automatically deleted when the system is shutdown and restarted.

BASIC DIRECTORY COMMANDS

PWD

The command pwd (print working directory) tells you what directory you are in

E.g. $pwd

Output is : /usr/user1

This command returns the pathname of current directory. The/denotes the root directory of the Unix file system. Within the root directory is a subdirectory called usr, within which there is another directory called user1 that is where we are now.

After logging in , user is taken into his own directory called HOME directory. HOME directory is assigned to each user of the system. It is the user's authorized workplace.

mkdir

To create a directory, Unix provides a mkdir command, which is a mnemonic for "make directory". At the shell prompt, type the command

$ mkdir dirname

rmdir

A directory can be removed using the rmdir command, which is a mnemonic for "remove directory". At the shell prompt, type the command

$rmdir dirname

cd

When a user creates a directory, he would obviously like to change to the directory. The user can change to the given directory by typing in the following command at the shell prompt

$ cd dirname

BASIC FILE COMMANDS

ls

The command ls lists the file in the directory. The command ls with no argument, lists the contents of your current directory as shown below:

$ls

Output is: abc

report1

report2

We can get a detailed information by adding arguments to the ls command. For example, the option l, when added, gives the following results:

$ls -l

Output is : total 6

drwxv-x—x 3 user1 group 80 Sept 20 18:11 abc

-rw-r—r— 1 user1 group 110 Sept 1 2:11 report1

-rw-r—r— 1 user1 group 32 Aug 1 9:45 report2

The first line of the display is a count of the total number of blocks of storage that the listed files use. The first character on each line indicates the type of file.

D : directory

- : ordinary

b,c,p : special

The next nine characters on the line are how every user on the system can access the file. These access modes apply to the file owner (the first three characters), other users in the same group (the next three characters) and finally to all other users of the system (the last three characters).

There are three different access modes:

“r” for read

“w” for write

“x” for execute

The next entry gives the number of links to the existing file. The two successive entries on the right are the names of the user and group respectively. These are followed by the size of the file in bytes. The date and time when the file was last changed comes next and the entry on the extreme right is the name of the file.

cat

Let's create a file on the system. Call the file "first" and store the given text exactly as shown:

$cat > first

I am enjoying doing Unix.

Unix is a wonderful OS.

Ctrl-d (ctrl and d keys pressed simultaneously).

$

This sequence creates a file called "first" containing the two lines. We can examine the contents of the file by using the cat command. The argument to the cat command is the name of the file whose contents have to be examined.

$ cat first

Output is : I am enjoying doing Unix.

Unix is a wonderful OS.

$

rm

No system that allows us to create files would be complete without a command that also allows removing a file. Under the Unix system this command is called "rm". The name of the file(s) to be removed :

$ rm first

cp

In order to make a copy of a file the "cp" command is used. The first argument to the command is the name of the file to be copied (known as the same file), and the second argument is the name of the file to place the copy into. We can make a copy of the file "first" and call it "second" as follows:

$cp first second

mv

We sometimes need to change the name of a file. This is accomplished easily with the mv command. The argument to the "mv" command follows the same format as the "cp" command. The first argument is the name of the file to be renamed, and the second argument is the new name. So, to change the name of the file "first" to "third", the following command is executed:

$mv first third

chmod

This command alters the modes of the indicated files and directories. A file mode, as discussed earlier, specifies who has to read, write and execute permissions. "chmod" sets permissions separately for each class of users, i.e. the user, group and others.

$chmod 777 first

The file permissions are described by a three digit octal number such as 777,711,536, etc.

where, 1 is for execute

2 is for write

4 is for read

777 means it is read, write and execute for owner, group and world. Here 7 means 4+2+1 i.e. read, write and execute.

THE UNIX EDITOR

In an operating system, an editor assumes a good amount of importance; it is the ultimate authority which helps create and modify user files and data. Hence, when you begin a new operating system, it is a good rule to get familiarized with the editor, so that creating and modifying files becomes an effortless process.

An ASCII text file, such as a document or a program may be created or modified using a text editor. There are two text editors available under the Unix operating system: vi and ed.

Ed is merely a line editor like edlin in DOS. Being a line editor, ed however, limits the user options because he can work only on one line at a time. We therefore, take a plunge into the vi editor straightaway.

As a matter of saying, vi stands for “visual”. Creating a file becomes a lot easier with the vi editor. Vi was the first full screen editor that allowed the user to view the entire document at the same time instead of navigating line by line.

Vi was created and written at the University of California at Berkeley by a man known as the “joy of Unix”, Bill Joy who is also one of the cofounders of the Sun Microsystems.

The vi editor can be invoked in different ways. A few of these are as shown below:

Vi : edits an empty editing buffer.

Vi name: edits a file with a specified name.

Vi+3 name: opens a file with a specified name and goes to the third line in the file.

Vi +/bye name : searches for the first occurrence of “bye” in the file.

Modes of Operation of the VI Editor

Vi works in three basic modes of operation:

Command Mode

In the command mode, all the keys pressed by the user are interpreted to be editor commands. No text is displayed on the screen in this mode, even if the key is pressed on the keyboard.

Insert Mode

A user can enter the insert mode by typing any of the VI insert, append, open, substitute, change or replace commands. Once the vi editor is in the insert mode, letters typed in at the keyboard are echoed in the editing buffer.

The Escape Colon Mode

It is also known as the ex escape mode. Ex has single line commands that are terminated with the “Return” key. Vi however, has commands which can be invoked with the press of a single key.

The bottom line of the vi screen is called the command line. Vi uses the command line to display messages and commands. When the user enters the escape colon mode, the command typed in is echoed at the command line at the bottom of the vi screen. There are no error messages in vi. Whenever the user makes a mistake, vi emits a meek beep in protest.

Important keys in the VI Editor

“Esc”: This key returns vi to the command mode.

“Return”: It executes commands entered in the “ex Escape“ mode and starts a new line in the insert mode. In the command mode, it simply takes the cursor to the next line.

“/”: It is used to specify the string to be searched in the existing file. The string appears on the status line following the “/” character which echoed at the beginning of the command line.

“?” : When this key is used instead of “/”, the search for the string proceeds in the backward direction.

“h or Backspace”: Left cursor movement.

“l or Spacebar”: Right cursor movement.

“j or + or Return”: Down cursor movement.

“k or -”: Up cursor movement.

“#w”: Move forward a word.

“#e”: Takes you to the last character of the word.

“#b”: Move back a word.

“o or ^”: Move to the beginning of a line.

“#$”: Take to the end of a line.

“Ctrl f”: To move a screen forward. The last two lines of the previous screen are displayed to maintain continuity.

“Ctrl b”: To move a screen backward. The last two lines of the previous screen are displayed to maintain continuity.

"Ctrl R or Ctrl L": To redraw the original screen and clear any error messages that vi has displayed or even the system messages that appear on the screen.

"Ctrl G": Displays the status on the status line. It displays the name of the file that is being edited, the current line number, the number of lines in the file and the percentage of the file (in lines) that precedes the cursor.

"I": I makes the insertion mode. Text is inserted at the current cursor position.

"O": O makes the insertion mode by opening a blank line above the current line.

"J": To join two lines of text in a file, position the cursor at the end of the line and press J. This command causes the line below the current line to join with the current line.

"#x": Deletes the character at the cursor position.

"#dd": Deletes the current line where the cursor is positioned.

"#dw": Deletes the word from the cursor position to the end of the line.

":q!": Quit from vi editor and abandon changes.

":wq": Quit and write changes to file.

COMMUNICATING WITH OTHER USERS

Unix has state-of-the-art communication utilities that added some life to this otherwise block and desolate Operating System. It is like a joyride that will make life in Unix for more pleasant and enjoyable.

The "Mesg" Command

The information displayed on the terminal comes from a "tty" file is the/dev directory. If a message is to be sent to another users' terminal, it implies that the message is to be written to his terminal file. This requires that a write permission be assigned to the terminal file for which, you have to be a superuser first.

All these problems can be avoided by using the "mesg" command to set the terminal to receive messages from other users. For example, if you are expecting from some other user, use:

$ mesg y

This command will alter the mode of your terminal file, so that messages from other, users can be written onto your file. Setting a write permission to your terminal can also be very annoying at times. For example, when you are editing an important file in VI, and some else writes on your screen, it is quite disgusting. This permission can be set off by using the command.

$ mesg n

Now all the other users except for the superuser will be denied permission to write to your terminal.

The "Write" Command

This is an easy way to communicate with other users who are logged in at the same time as you provided the terminal files are granted "write" permission. The syntax of the write command is as follows:

$ write user [tty]

User is the logname of the user you want to communicate with. The 'tty' number is optional, so long as the user with that logname is logged onto only one terminal. To communicate with a user with logname "bb8", the command is:

$ write bb8

I will meet you tomorrow at 10 : 30.

—— user 1

(Ctrl – d)

$

The user bb8 will hear a beep on his/her, terminal followed by the display of the message.

The "news" command

It permits users to read messages published by the System Administrator. The important news is saved as a file in the /usr/news directory so that it may be available to all users. To see any messages that the System Administrator has typed, use:

$ news

The news appears here.

Mail : The heart of Unix Communication

Mail in the computer world, refers to textual information that can be electronically conveyed from one user of the system to another. A portion of mail that was sent or received at one stretch is referred to as a message which may be a single line of text or a program containing several hundred lines of code. The conventional mail system of Unix accepts only textual ASCII files that are acceptable to standard editors. Binary files, executable files and other special files cannot be sent.

There are two forms of the mail command. The first form sends mail to users with the indicated login names. The second form reads mail sent to you. Just as a postman drops all the mail in your mail box, all incoming mail in Unix is stored in a file in the /usr/mail directory, with one file for each user.

To send mail to other users, the format of the command is:

$ mail name (s)

where names are the login names of the users. Now, type your message terminating it by typing (Ctrl –d). Instead of typing your message, you can also use redirection to send input from a file, as in

mail user 1 < new infor

Redirection

Redirection changes the assignments for standard input and standard output. That is, whenever data is to be read in from a file other than the standard input or sent to a file other than standard output, Redirection is used. It is always specified on the command line and is handled by the shell. Redirection is further classified into input and output redirection.

Under the Unix system, the output from a command intended for standard output or monitor (stdout) can be diverted to a file. This capability is known as output redirection. The operator used for output redirection is shown below:

> : This operator makes the filename following it, become the new standard output.

Eg. Cat file1 file2 >file3

The operator > declares file3 to be the standard output. Thus the output produced by cat is sent to file3 and not to the screen. If a file with the name “file3” already exists, it is over written with the new data, otherwise, it is created.

Now, let’s take a look at input redirection. Just as the output of a command is redirected to a file, the input for a command can be redirected from a file. The operator used for input redirection is described below:

< : This operator makes the files following it, the new standard input.

Only the commands, that normally take their input from the standard input, can have their input redirected from a file in this manner.

Eg. $ cat < example

C++ is more powerful than C language

$

The file “example” became the standard input and its contents were reported to the screen by cat.

Pipes

The Pipe is one of the most important tools available in the Unix Operating System. A Pipe is a mechanism by which, the standard output of one program or command can be channeled into the standard input of another program or command.

A pipe can be made between any two commands or programs under the Unix system, provided the first writes its output to the standard output and the second reads its input from standard input.

FILTERS

Many Unix commands are designed as filters. A filter is a program that can take a flow of data from standard input, process or filter it, and send the result to the standard output in a particular format. The use of filters makes connecting the commands a very natural process.

wx

Counts lines, words and characters

This command is used to count the lines, words or characters in the file.

The syntax is:

Wx - [option (s)] [filename(s)]

Option	Action
-l	count lines
-w	count words
-c	count characters

pg

The paginator

This filter is a paginator that allows you to view one screenful at a time. The pg command displays a prompt that pauses for the user to strike the “enter” key to continue scrolling. At the End of the File, it displays “(EOF):” and waits for the user to terminate the process by striking the “enter” key.

grep

Global regular expression printer.

This command is used to search and print specified patterns from a file or the standard input. The word “global” specifies that the entire file or standard input is scanned to search for the pattern. The term “regular expression” specifies that meta-characters can also be used to facilitate pattern searching. And finally, the word “print” suggests that the lines that contain the pattern will be displayed on the standard output. The syntax is

$ grep pattern filename

E.g. $cat data

canada

china

argentina

india

japan

Lets say the pattern “in” is to be searched in the file. The command and output will be follows:

$grep in data

china

argentina

india

tr

Character transliteration

tr replaces characters in one list with the corresponding characters in the second list.

E.g. $ cat data

canada

china

argentina

india

japan

Now let us replace character “n” by “#” and character “I” by “%”.

$ tr in % # data

ca#ada

ch%#a

arge#t%#a

%#d%a

japa#

Sort

The sort command sorts and merges files.

E.g. $ sort file1 file2 >file3

The contents of file1 and file2 are merged, sorted and redirected to file3.

cut

This command is used to cut out selected fields from a file and display them. It is useful with documents like financial reports and statements that contain data in a tabular format. Two formats can be used with the cut command. Fields can be cut by specifying the number of columns or by specifying the number of fields using a delimiter.

The syntax is:

$ cut option file-name

Option	Action
-clist	passes the columns indicated by list. For example, -c10-15 means "pass columns 10 thru 15". no spaces are allowed in typing the option.
-flist	passes the fields indicated by list. -f1, 3 means "pass fields 1 and 3".

Paste

The paste command merges the contents of multiple files and displays them side by side on the screen. This filter is useful to generate output in a columnar format. The syntax is:

$ paste option filename

WORKING WITH THE BOURNE SHELL

Shell Environment

Each process in the Unix system has available to it, an array of strings called the

Environment. The Shell Environment is defined as a set of parameters which affects the functioning of a shell. Whenever you log onto your system, you are given your own copy of the shell. You are set up in your own little world known as your environment.

Most computer languages have variable and so does the shell. Shell variables come in two variables namely:

Common Environment Parameters or System Shell Variables:

The shell maintains it's own set of shell variables. Your own system may add to or subtract from this list. Here the some standard shell variables found on many systems:

- Home:

Home is an environmental variable, that is already defined to contain the path for your HOME directory. When you simply type the command

$ cd

the value of HOME is appended to this command and you are automatically taken back to your HOME directory.

$ pwd

/usr/ashish

Try printing the value of this variable at your terminal and see what happens:

```
$ echo $HOME
/usr/ashish
$
```

- PATH:

This variable names the directories that the shell has to search to find the commands that you execute. When you log in, your PATH variable is set to some default value. See what it is set to now:

```
$ echo $PATH
:/bin: /usr/bin
$
```

It contains a list of all directories that will be searched whenever you type in the name of the program to be executed. It also specifies the order in which the search will be performed. The directories listed in the PATH variable will be searched by the shell from left to right. A colon (:) separates one path from the next is the list. A colon at the start of the list means that the current directory is to be searched first.

The value of the PATH variable above indicates that three directories are to be searched whenever a command or program is to be executed: first the current directory, then the directory /bin and finally the directory /usr/bin. As soon as the shell finds the program in one of these directories, it executes it. For example, if you give the command ‘cat’, the shell first searches your current directory for an executable file named ‘cat’. If it does not find one there, then it searches in /bin. If it still hasn’t found cat, it looks in /usr/bin. If cat is still not found, the shell reports back that it cannot find the command. This particular sequence means that, if you have an executable file in your current working directory, that cat is executed rather than the standard system cat.

- MAIL:

This variable defines the path and the name of the file in which the user's mail should be stored. In other words, the value of this variable is the name of the directory in which the electronic mail addressed to you is placed. The shell checks this directory very often and when something new is found, you are notified that new mail has arrived for you.

- LOGNAME:

This variable contains the users’ login name which was assigned to the user when his account was created on the system.

User – defined Parameters or Shell Variables

A shell variable can be created by typing the following form of command at the shell prompt:

$ x = 10

Local and Global Shell Variables

Ordinarily, any shell variable is known only to the shell to which it is a created. It is hence a local variable. This implies that whenever you start a new shell, the new shell is ignorant of the old shell's variables. It is often required that the new shell knows about the variables of the old shell. This can be accomplished by using the export command. Any shell variable used as an argument for this command, will have copies of the variable and its value presented to all shells descending from it. This kind of variable is called as a global variable. Subsequently, the value of the copy can be changed, but when the subshell dies, so does the variable. To find what variables are already exported, type *export* without any argument.

Modes of Command Interpretation

The modes of command interpretation in Unix can be classified as follows

- The Interactive Mode

An Interactive program user for input by asking a question and then reads the user's answer. The shell is an interactive program, it prompts with $ and reads the commands you type at the command line. The command line approach or the interactive mode is powerful and flexible but not exactly user-friendly. In this approach, the script accepts arguments from the command line. These arguments come directly after a command name. Most Unix commands works this way. In cat names, names is a command line argument which tells cat which file to process.

- The Batch Mode

In this mode of command Interpretation is through shell scripts. In this approach, the user writes an interactive script that requests the information it needs from the user. The interactive shell scripts are based on the UNIX shell commands read and echo and shell variables.

SHELL PROGRAMMING

The kernel is the heart of Unix operating system. It is the master program which controls the computer resources allotting them to different users and to different tasks. However, kernel does not directly deal with the user. Instead, it starts up a separate interactive program, called shell, for each user when he logs in. The shell then acts as an interface between the user and the system. In its role as command interpreter, the shell takes in a command and sets it up for execution. But it is the kernel which decides exactly when each requested program is to be run by looking in to the demands of the different shell users. The shell and the kernel work together to provide Unix services. In fact only one process goes on as the processor is so fast that it can switch from one process to another dedicating itself to one process at a time. This gives an illusion of simultaneous action.

Characteristic of the Shell

Acts as interface to the Unix operating system.

Acts as a command interpreter.

Provides a programming language with concise but powerful syntax.

Standard I/o can be redirected to files.

Process can communicate through pipes.

What Makes Shell Powerful as a Programming Language

Shell scripts can take arguments like most commands. These arguments can be symbolically represented with the script. Thus, we can provide values, filenames and the like to be used as arguments for commands inside the script.

The shell allows us to create shell variables and allows us to assign values to them. They can be used by shell scripts for many purposes. Most important of all, it provides control structures such as if ..else constructs and for loops which are very much similar to any other programming language.

A shell script built upon standard Unix commands is highly portable from one Unix system to another. Scripts take up very little space.

SHELL META-CHARACTERS

File name expansion is the ability to expand shorthand notation for groups of filenames to a complete set of explicit filenames. The shell uses a set of special characters called metacharacters to produce patterns to match various classes of filenames.

‘*’ : This metacharacter stands for any combination of one or more Characters

E.g. $ls s*n

Output is : sun

Sin

Son

Seen

S*n stands for all filenames beginning with ‘s’ and ending within ‘n’. If there are files whose names are sun, sin, son, seen, etc. then, on giving the above command, you will see the names displayed as above.

‘[]’ : This metacharacter lets you choose one character out of a range of characters enclosed within the square brackets.

E.g. $ ls d[io]g

Output is : dog

Dig

D[io]g refers to the names of all files which start with d, end with g and have either i or o at the second position in the name.

SHELL VARIABLES

A variable is a name associated with a value. It offers a symbolic way to represent and manipulate data. Two of shell variables are:

User Created Shell Variables

E.g. $bookname=oracle

$weight = 72

So, above are created two variables, bookname and weight with values “oracle” and “72” stored in them.

System Shell Variables

The system maintains its own set of shell variables. Some standard shell variables are:

HOME : to set pathname of your home directory.

LOGNAME : the user login name.

MAIL : this variable value is the name of the directory in which the electronic mail addressed to you is placed.

PATH : this is the name of the directories, which the shell will search to find the commands that you use.

Shell Scripts

It can be created by placing Unix commands into a text file. This can be executed by typing sh followed by the filename.

E.g. Let us consider a file named ex1 which contains the following three commands:

Exe1: example of shell script

Ls

Cat file1

Cp file1 file2

The command "$sh exe1" will run the shell script. As a result of execution of the commands in the file exe1 we get a list of files in the current directory (because of ls). This is followed by contents of file file1 (cat file1) followed by contents of file file1 being copied to file2.

Interactive Shell Scripts

Interactive shell commands are based on the Unix shell commands read, echo and on using shell variables.

E.g. Consider the file named exe2 containing the following lines.

#exe2: interactive script

echo enter your name \?

Read name

Echo glad to meet you, $name

The command "$sh exe2" will respond: enter your name?

Peter (user's response)

Glad to meet you peter.

In the script, the '\' is used to remove the special meaning of ?, the read statement assigns your typed input to the variable name. The echo $name command, causes this value to be printed out.

Shell Scripts Arguments: Positional Parameters

Consider the example

$ cp file1 file2

Here file1 and file2 are first and second arguments to the command 'cp'. Similarly in a script, arguments may be used. They are referred as $1, $2, $3 and so on for the first, second arguments respectively. The special argument $0 means the command or the script itself.

S* Stands for all arguments from $1 up

S# Stands for the total no of arguments. $1, $2 etc. are called positional parameters

- Set

This command is used to assign values to positional parameters.

E.g. $ set one two three

$ echo $2 $1

Output is : two one

In the above example, by giving the first command we are assigning the values 'one', 'two', 'three' to the first, second and third positional parameters. The second command echoes the values stored in the second and first positional parameters.

- Command Substitution

$ echo date

date

$ set 'date'

Sat Oct 23 10:47.31 IST 1999

Set is often used in conjunction with metacharacter ' (Back quote). When a command is enclosed in back quotes the command is substituted by the output of it. This is called command substitution.

Special Command Line Characters

Word Separator

These are characters used to separate one word from the other. Normally these are space, tab and new line character. IFS is the internal field separator.

If you give the command

$ IFS = Q <CR>

then a command

$cp defoe friend <CR>

would look like

$ cp Qdefoe Qfriend <CR>

The space between the words is substituted with the IFS.

Sequential Commands:

Semicolon (;) is used to separate commands in a line.

Eg. $ cat file; cp file1 file2; mv file2 file3

The three commands in the line are separated from one another by ‘ ; ’

Background Process

When a job is run in the background the process is launched and control returns to the shell immediately.

$ spell story story.spell R

Output is : 4562

This tells the job has been launched is the background and it has been given a process Identify No 4562. The result of execution will be redirected to the file story.spell. This leaves your terminal free for any foreground processing. Had we not used the redirection symbol to route the results of the background processing to the file names story.spell then they would have flooded your screen since your screen is the standard output for background processes also (may be you were in the middle of a heavy editing task and you would not want to be disturbed).

Command Grouping

Parenthesis are used to group more than one commands together.

Eg. $ (date; cat results) >data <CR>

And

$ date; Cat results >data <CR>

The above two commands are not the same. The second command may be interpreted as a series of two commands like:

$ data <CR>

$ Cat results < data <CR>

In the first case, the result of execution of the, 'date' command as well as 'cat results' will be redirected to the file named *data*. Where as in the second command, only the result of executing 'cat results' will be redirected to the file named *data*.

Redirection : Standard Error, 2>, >&

The standard error is the terminal. It can be redirected to a file by preceding the name of the destination file with 2.

0, 1, 2 are file descriptors assigned by the system to standard input, standard output and standard error.

Eg. $ cp file1 file2 <CR>

Output is : cp : Cannot open file1.

Here we got the error message on our terminal.

If we give the command as follows order to redirect the error message to a file named err:

$ cp file 1 file2 2>err <CR>

Then, seeing the contents of file named *err* will show the same error message that we had seen on our standard terminal.

$ cat err <CR>

Output is : Cannot open file file1

Standard error redirection are applied mostly in background jobs. We can give for example

$ sort data file >sorted 2 >sorterr & <CR>

Here we have given the command to sort a huge data file and to store the sorted output on a file named sorted and any error messages or errors in another file named sorterr. We are fixing the job in the background since it is a huge file and it may take long time.

To redirect the standard output as well as the standard error to the some file we can use.

2 >1 or 1 >2

Conditional Execution : && and ||:

These symbols are used to execute a command based on the condition that some other command has failed or succeeded.

&& : To execute the second part of a sequence of commands only if the first part succeeds.

|| : To execute the second part of a sequence of commands only if the first part fails.

Every Unix command provides on exit status which is:

0 : If the command runs successfully without any error.

Non zero value : If the command goes wrong.

Eg. $ grep rose flowers && echo beautiful flowers !! <CR>

$ grep rose flowers || echo no rose !! <CR>

The first example tells that if grep finds a string ‘rose’ in the file flowers then the echo command following it is executed and you see ‘beautiful flowers’. The second example tells that the grep command tries to find the string rose in the file flowers. If it does not find (i.e. its exit status is non zero) then the following command is executed and you see ‘no rose’.

Command Terminators

The following are used as command terminators:

→ newline <CR>

→ ;

→ &

eg. $ cd work; ls –l <CR>

$ spell book >sp & ed opera <CR>

In the first command line, the first command is terminated by ‘;’ and the second command is terminated by a new line character which is <CR>.

In the second command line, the first command is terminated by firing the job in the background (the command preceding the '&') and the file named 'opera' is opened for editing. (The first command is terminated with an '&' and the second command is terminated with a new line character).

Special Shell Variables

$# : the no of positioned parameter

$? : the exit status of last command executed

$$: the process no. of the current shell

$! : the process no. of the last background job

$0 : the name of the command being executed

$* : list of positioned parameters

$- : shell options

eg. $date >> datelog <CR>

$ echo $? <CR>

Output is: 0

The above command appends the result of execution of the 'date' command to the file named datelog. The second of the above command echoes back the exit status of the first command, which is '0' i.e. it was successful.

Eg. $ date >> datelog & <CR>

Output is: 4321

$ echo $! <CR>

Output is : 4321

Here the date command is executed in the background. The second command gives back the PID no of the last job executed in the background which is 4321.

Looping

The significant aspect of shell as a programming language is its ability to control flow of a program.

For loop

A loop in programming device that lets cycle through the same steps several times.

General format:

For variable in value1 value2¼.

Do

Commands

Done

E.g. Consider the script exe3 containing the following lines:

For I in 1 2 3

Do

Echo $I

Done

$sh exe3

output is : 1

2

3

While Loop

Unlike the for loop which executes for a list of values until it is exhausted, the while-until loops execute until the control command fails. During each loop the control command is first executed. If it succeeds (returns 0 exit status), then the commands between do and done are executed. This goes on until the command returns a non-zero exit status.

Syntax of while loop:

While condition

Do

Commands

Done

Until Loop

This is similar to while loop. But the sequence of commands between do and done here are executed as long as the control command is not true (has a non-zero exit status). When it attains a zero exit status, the loop terminates.

Syntax of until loop is:

Until condition

Do

Commands

Done

Case Statement

The case statement lets a shell script choose from a list of alternatives. General format is:

Case value in

Choice 1 command;;

Choice 2 command;;

Choice 3 command;;

Esac;

If the variable has the same value as choice 1 then the commands following choice 1 are executed. If it is the same as choice 2 then those following it are executed and so on.

Conditional Statement

The if Statement

The if statement is concerned with the status of commands like while and until.

The syntax is:

If control command

Then

Commands

Fi

First the control command is executed. If it has a zero exit status i.e. it is successful then the commands between then and fi are executed. The words if, then and fi must come at the beginning of a command line or just after a semicolon.

IF..THEN..ELSE

The syntax is :

if control command

then

commands

else

commands

fi

If the control command has a zero exit status then commands following "then" are executed, else if it has a non zero exit status then commands following "else" are executed.

The Test Command

Supposing we want to know whether an argument is a file or a directory, or whether a script has got the right no. of arguments or whether the correct code word has been entered or not. For this we use the Test Command.

Eg. Suppose we want to see if a shell variable called name has value robin, we test for equality by using text command.

$ name = robin <CR>

$ test $ name = robin <CR>

Here the test command although did not produce any output it has produced an exit status. The test command produces a '0' exit status if it is successful and '1' if it is unsuccessful. If we give the command to know the exit status of the previous command.

$$? <CR>

Output is : 0

Eg. Consider the script test sc containing the following lines:

```
# testsc : test statement
echo what is the best operating system \?
read OS
if test $OS = unix
echo it is correct
else
echo who said that \?
fi
```

Eg. Consider the script inpass6 containing the following lines.

Inpass6 : Checks password file for login and failing that checks the group file.

```
BB = /dev/null
for name in $@
do
if test ‘grep $name /etc/group >$BB2 >$BB’
then
echo $name is in group file elif test ‘grep $name /etc/ password >$BB2 >$BB’
then
echo $name is in password file
else
echo $name is not in either
echo password or group file
fi
```

exit 0

$ chmod u + x inpass6 <CR>

$ inpass6 user1 user2 user3 <CR>

User1 is in the group file

User2 is in the password file

User3 is in the password file

Here 'test' returns true if grep return true, or false if grep returns false. If grep returns true for sawita, then test returns true. Hence the command following it will get executed.

File Checking

Whether a file has read, write or execute permission, whether it is a directory, if it exists, all these can be checked by the test command with appropriate options.

-r file : If the file exists and readable.

-w file : If the file exists and writable.

-x file : If the file exists and executable.

-d file : If the file exists and is a directory

-s file : If the file exists and has size greater than 0.

Eg. Suppose we want to find out whether we have permission to change file or not.

$ test –w wfile <CR>

$ echo $? <CR>

Output is : 0

String Checking

Suppose we want to compare two strings, then it can be done in this way :

String1=string2 true if string1 is equal to string2.

String1!=string2 true if string1 is not equal to string2.

Numerical Comparisons

N1-eq n2 (n1 equal to n2)

N1-ne n2 (n1 not equal to n2)

N1-gt n2 (n1 greater than n2)

N1-lt n2 (n1 less than n2)

N1-ge n2 (n1 greater than or equal to n2)

N1-le n2 (n1 less than or equal to n2)

Logical Operator

! negates the following expression

-a binary and operator

-o binary or operator

Using Arithmetic Computations: Expr

To find the sum of two numbers

E.g. $ expr 5 + 6

11

$expr 12/6

2

$expr 4-1

3

UNIX SYSTEM ADMINISTRATION

Under normal conditions Unix system does not require much attention, but for security reasons certain jobs like maintaining user accounts, installing software, system startup and shutdown, cannot be automated. Also, under certain abnormal conditions, system may crash due to faulty hardware, runaway user programs, faulty disk etc. In such cases, some administrative commands are available to aid the system administrator.

Some of the responsibilities of a system administrator are:

System startup and shutdown

Maintaining file systems

Taking regular backups

Disk usage maintenance

Adding and removing users

System security.

For accomplishing all the above functions many system administration commands are available with the Unix system. Most of these commands are run by a special user knows as 'superuser'. The logname of super user is the root. It has all the privileges that the other users don't have like modifying, deleting or running any file regardless of permissions associated with them.

How to become a 'Super User'?

There are two ways to become a 'super user':

- Login as root : At login prompt type,

Login : root <CR>

Password : // type the root password.

- At the '$' prompt, type 'su' command followed by enter key:

$ su

Password : // Type the root password.

Knowing about Devices attached to your system:

In Unix system every device is treated as a file. These files are known as 'special files'.

Each device connected to the Unix system is represented by a file in the '/dev' directory. These files are usually referred to as 'Device Files' (or) 'Special Files'. To look at some of the devices connected to your system, change your directory to '/dev' directory and give 'ls –l' command.

How does the kernel distinguishes between regular files and device files?

Suppose you give the following two commands

$ cast temp and $ cat /dev/tty/15

Before interpreting the above two commands first let us loot at what exactly the physical directory contains.

Each physical directory (Internal representation) entry contains two columns namely.

Files name and pointer to Each inode contains the

The Inode list following information

Filename Inode Inode mode, start file, date

no. entry, file size of creation

Temp1 120 ....

The Inode list entry consists of Inode number, mode entry, start file, file size, file created, etc. For 'special files' instead of the file size it contains the major and minor numbers.

When you issue the command like ‘cat temp’ the kernel looks for the Inode number in the current directory and looks for the mode entry (for special files it is either ‘c’ or ‘b’) and learns that ‘temp’ is an ordinary file and as usual it looks for the corresponding blocks in the inode entry and prints their contents.

When you issue the command ‘cat /dev /tty 15’ the kernel as usual looks for inode number in the current directory and looks for the mode entry and learns it is a device file. It then checks for major and minor numbers and identifies that it is a terminal. It then makes an appropriate I/O connections with the Terminal and the kernel I/o subroutines transmit keyboard generated bytes (the characters you type) to ‘cat’ program. Finally when you type ctrl –d at the beginning of a line the program finishes up its work and terminates. Ctrl –d identifies the end of the input.

The ‘getty’ Process

Each terminal has one ‘getty’ process running even if some one has not logged in. The ‘getty’ process does nothing until a terminal is connected to the port. When you switch on the terminal the ‘getty’ process sends ‘login’ prompt to the terminal, then it waits for your response. When you type in your login –id, the ‘getty’ process starts up a new process known as ‘login’ process and gives it whatever login –id you have typed and goes away. The ‘login’ process then sends ‘password’ prompt and gets password from you. If either of these are not correct then it goes into the cycle. After successful verification of your login –id and password it then starts up our familiar process known as shell and goes away. The shell then sits between you and the kernel and executes your commands. When you press ‘Ctrl’ and ‘d’ (or exit) at the ‘$’ prompt, the shell then dies and ‘getty’ process resumes.

STARTING THE UNIX SYSTEM

Starting the Unix system requires more than just turning on the power. You must perform a series of steps to initialize the system for operation. This involves something called Booting the system, clearing the file system (if the system was improperly shutdown), entering into System Operation Mode to check the system operation and making sure that every thing is OK before allowing the other users to login to the system, etc.

Booting the system is nothing but reading the kernel from the disk into the system’s Main Memory. Some systems prompt you for some input to boot the system and some systems boot automatically when you power on. You should check the Manual that came with your system for a section on ‘Starting the System’ or ‘Booting the System’.

For example the SCO Unix displays the following message when you power on

Boot

:

Hit <CR> key to load the kernel.

After loading the kernel into the Systems Main Memory, the kernel checks the root file system to see that it is in order and not corrupted. If the root file system is corrupted (this usually happens when you STOP the system improperly or occasionally due to hardware failure or system crash), you have to clean the System to enable the Operating System work properly. If you get message of something like the following:

Proceed with clearing (y or n)?

Then the system was not properly stopped. You give ‘y’ to clean the file system. If you don’t get the above message then your file system is clean and ready for use. When your file system is clean and ready for use, you get a message type Ctrl –d to continue with normal startup (or) give the root password for System Maintenance.

You can choose either Multi user mode (by pressing Ctrl –d) or single user mode (by giving the root password).

Multi User Mode

In this mode (or) level, the Unix system allows more than one user to login to the system by running 'getty' processes.

Single User Mode

In this mode the Unix system allows only the super user to use the system. No 'getty' processes running, no other users and the only processes are 'init' 'swapper' and those run by the System Administrator from the console.

The 'init' Process

'init' is the process that control the level (or) mode the system is in. When you type 'init n' at the '#' prompt, the Unix system goes into level 'n', where 'n' ranges from 0 to 6 and the letter 's'. 's' is for single user mode and 'z' is for multi-user mode. When the System changes initialization state, 'init' reads the file /etc/inittab' for instructions that apply to new mode (or) level.

The '/etc/inittab' is made up of entries that contain the following four fields separated by colon (:).

Id : level : action : process

Id : To uniquely identify each line

Level : One (or) more numbers (o through 6) or the letter 's' that determine what level(s) 'action' is to take place.

Action : One of the following represent action that takes place.

'init default' : When 'init' starts it will enter 'level'. The process filed for this 'action has no meaning'.

'system init' : runs process before 'init' sends anything to the system console.

'respawn' : if process doesn't exists, starts it, waits for it to finish and then starts another. Eg. Getty – login – shell – log off – respawn getty.

'wait' : When it changes 'level', it starts process and waits until its finished.

'off' : when it changes 'level' it kills process.

The 'cron' Process

Cron is a process that runs when the Unix system is in multi-user mode.

It runs commands at specified dates and times. Once in every minute it checks the file ‘crontab’ to see if something is supposed to be run. If it finds something, it runs the corresponding command, other wise it sleeps for another minute. Since ‘cron’ never exits, it should be executed only once. This is done through ‘/etc/rc’ file at system boot time.

The ‘Crontab’ file

A ‘crontab’ file consists of lines of six fields each. The fields are separated by spaces (or) tabs. The first five fields are:

Minute (0 – 59)

Hour (0 – 23)

Day of the month (1 – 31)

Month of the year (1 – 12)

Day of the week (0 – 6 with 0 – Sunday)

Each of the fields may be either an asterisk (‘*’) (means all legal values) or list of element separated by commas (‘,’). An element is either, a number (or) two numbers separated by minus (‘-‘) sign (indicates the range).

Minute (0 – 59)	Hour (0 – 23)	Day (1 – 31)	Month (1 – 12)	Day of week (0 – 6, Sunday –0)	Command
0	7	*	*	1 5	......
15	7	*	*	2, 4	......

The sixth field in ‘crontab’ file is the command that has to be executed by the shell at the specified times. A percent sign character in the filed (unless escaped by ‘\’) is translated to a new line character. Only the first line (upto a ‘%’ (or) end of line) of the command field is executed by the shell. The other lines are made available to the command as standard input.

The ‘crontab’ is generally used to run the programs on a regular basis throughout the day. As a super user you can edit this file with any text editor and keep the commands which you want to run on a regular basis. Let us look at a typical ‘crontab’ file (on some systems this file is stored in ‘/usr/spool/cron’ directory).

$ cat / usr / spool /cron / crontabs

08 13 * * 1 – 5 / etc/wall </bin /wallmsg

10 13 * * 1 – 5 /bin /bkup > /dev/null

The ‘etc /motd’ file

This file contains the messages of the day that are to be displayed whenever a user logs into the system. The general messages include 'messages such as a reminder to clean up unwanted files/directories', a notice of the next periodic back up, and so on.

The '/etc /motd' file is an ordinary text file, so you can edit the messages with any text editor.

$ cat /etc /motd

Output is : Hello welcome to Unix Multi-user System Wish you a happy day.

The '/etc /profile'

This is a shell program (like your own profile) that is executed by the shell whenever a user logs in (before executing profile). This file is maintained globally by the system administrator. Some commands which you can mention in this are setting the terminal type, printing the messages of the '/etc/motd' file, printing the date and time, system name, terminal number, number of users and other information of interest to various users logging in.

As a super user you can edit this file and put messages in it to show to that you want all users.

STOPPING THE UNIX SYSTEM

When you want to turn off the Unix system, you shouldn't simply turn off the computer. You must prepare the system by using the 'shut down' command. The shutdown command must be run from the systems console and you must be logged in as 'root'. If any users are logged in after you issued 'shutdown', it warns the users that the system is about to be stopped, gives them the opportunity to finish their work, and then goes about killing processes, and finally it unmounts all file systems.

File System Maintenance

Each Unix System has atleast one file system on the primary hard disk. This file system is called 'root file system'. On small hard disks, this root file system contains user directories as well. The primary hard disk can also be divided into more than one file system, one of the most common file systems is the '/u' file system, which contains user accounts. The Unix System may also contain other file systems that contain special directories and application programs.

Advantages of having different file systems are:

- Protect the data
- Easier maintenance

New file systems can be specifically created by the System Administrator, then attached (mounted) and detached (Unmounted), to the system when needed.

The following commands must be run only by the System Administrator

Creating File Systems

The command used to create a file system is:

/etc /mkfs

'mkfs' stands for 'make file system'.

/etc /mkfs <special file> <size> <no of inodes>

where

Special file : Name of the special device on which to create

Size : Size of the file system in terms of blocks (block size is : 512 or 1024).

No of inodes : Maximum number of inodes.

If you don't specify the maximum number of inodes, then the Unix system calculates it to be

Maximum number of blocks /4.

Mounting a File System

Mounting a file system is nothing but attaching it to the overall tree structure.

/etc /mount command

The '/etc /mount' command is used to attach a file system anywhere in the overall directory structure. e.g.

/etc /mount <option><special><directory name>

Options:

-r : The file system is to be mounted read only

-v : displays mount information verbosely

-f fstyp : fstyp is the file system type to be mounted.

'special' : indicates the block special device that is to be mounted on 'directory'.

'directory' : indicates directory mount point for special. The 'directory' must already exist and must be empty.

Unmounting a File System

To unmount (detach) a file system, you can use the command '/etc /unmount'. This command is simply the reverse of the '/etc /mount' command, it removes the file structure from the directory structure.

Note the following things before unmounting any file system

→ first use 'sync' command to perform any pending I/o:

→ the 'root' file system can not be unmounted.

→ Unmounting file systems is usually done only in single user mode.

→ '/etc /umount' will not work if any file is in use in the file system you are trying to unmount.

/etc /unmount <special>

where

'special' : indicates the previously mounted special device that is to be made unavailable.

The 'sync' Command

The 'sync' command is used to perform any pending I/o before unmounting any file system.

```
# sync
#
```

Displaying Free Space

The 'df' (disk free) command displays the number of blocks and inodes available on the specific file system. A block is generally 512 (or) 1024 bytes of data.

You can find the percentage of free space to total space on your system with the command:

```
$ df –v
```

Mount dis	Filesystem	blocks	used	free	% used
/	/dev /disk/35root	70000	4688	65312	6.6%
/usr	/dev/dsh /353	100000	93158	6832	93%

Displaying Disk Usage

You can display the number of blocks used within a directory by using the command ‘du’. This command is used for finding excessively large directories and its subdirectories. The ‘du’ prints a list of each directory in a file system along with the number of blocks used by the files in that directory and its subdirectories. The ‘du’ command with ‘-a’ option prints out the sizes of the ordinary files as well as the totals for each directory.

$ du –a

38 /u1.txt 1./t1.4

22 /ufchap2

47 /ufchap3

The ‘wall’ Command

To broadcast a message to all users on the system ‘wall’ (write to all) command can be used.

wall

Body of the text

<Ctrl + d>

This command copies the messages you enter at your terminal to the terminals of all users currently logged in.

Locating Files

You can locate all files with a specified name, date, owner, and/or last access date by using the ‘find’ command.

$ find USER1 name – memo2 – print

This finds the file ‘memo2’ in the directory USER1 and all its subdirectories. If the file ‘memo2’ is found, its path from directory USER1is printed else nothing will be printed on the screen.

Saving and Restoring File System

Unix System provides several mechanisms for backing up file systems and a corresponding method for restoring file system. Simple backups can be done by using ‘tar’ command. Though the ‘tar’ command is not sufficiently sophisticated to perform Scheduled backups, it is better suited to archive groups of files. The key to efficient backup is to save only what has changed from day to day (incremented backups).

The ‘Tar’ Command

'tar' stands for tape archiver. The 'tar' command is useful for making a backup copy of entire directories. It takes as its arguments a command and a directory to be archived onto a tape or another disk.

E.g. $ tar cv2*

It copies all files in the current directory into a high capacity/DSHD floppy diskette.

Accounts Management

Add /delete Users

Use can add users by directly modifying, 'etc/password' file. The '/etc/password' file is an ordinary text file that contains information about all users on the system. Each line in the file corresponds to one user on the system. This line contains information about that particular user.

The general format of each line in the file is:

Login id : password : uid : gid : userinfo : HOME : shell

Where

login id : users login name

password : encrypted password

uid : numerical userid that be associated with login id.

gid : group id that is used to distinguish members of various groups.

userinfo : other details about the user.

HOME : Users' Home directory. It must be a valid directory and cannot already exist on the system. Typically the user's HOME directory matches the login name. For example, the login 'user1' might have HOME directory of /usr/user1.

shell : Specifies 'shell' for the user (Bourne or C)

Let us now see how to add a new user, user15.

First open '/etc /password' with any text editor and add the following line to the end of the file.

User15:: 120 :: 17 : D.K Dhingra :/trng/user15: /bin/sh here,

login id : User15

uid : 120

gid : 17

userinfo : D.K. Dhingra

Home : /trng /user15

shell : /bin/sh (Bourne Shell)

Next step is to create the user directory

mkdir /usr /user15 || create directory

chown user15 /usr /user15 || assign owner

chgrp 17 /usr /user15 || assign group

To assign the password to ‘user 15’

password user15

New password : <New password>

Reenter new password : <new password> || for confirmation.

#

Now ‘user15’ account has been created and is allowed to use the system.

Adding users with ‘add user’ command

Syntax :

Adduser <login – id> <name> <user – id> , <home – directory>

So in the above case it will be:

adduser user15 D.K. Dhingra /70 /usr/user15

The above command adds ‘user15’ to the system.

Removing Users

Removing users is simply the opposite of adding them.

Removing users by directly modifying /etc/passwd ‘file:

First, open ‘/etc/passwd’ file with any text editor and delete the line corresponding to the user. Next, remove the users HOME directory and all of the files by the command:

rm –r/usr/user15

Removing users with ‘deluser’ command:

Deluser <login – id> <yes/no> <home –directory>

Yes /no is for confirmation

Eg. # deluser user15 y/usr/user15

System Security

System security is one of the primary important features for multi-user systems. Two major areas where security should be ensured are:

Password Security: to keep unauthorized people from gaining access to a computer system.

File Security: To keep unauthorized people from tampering with the user's files and to allow some users certain privileges that other's aren't allowed.

UNIX UTILITIES

UNIX includes and supports several utilities, which allow communication from one system to another. When an entire network of interconnected Unix system is available; the users can use it for mail service between different machines apart from other services. The services may be:

Remote login(TELNET)
Electronic mail(SMTP)
File transfer (FTP)
Trivial File Transfer (TFTP)
R-Series Applications
Printing On A Remote Printer, Etc.

REVISION EXERCISES

1. Define an operating system?
2. What are the components of an operating system?
3. Differentiate between the three types of translators.
4. Enter your login name at the login: prompt and log onto the system.
5. Display the system date.
6. Display the terminal address of all the persons working on the Unix system.
7. Using the echo command, dial "I AM LEARNING UNIX".
8. Give a brief idea about the Unix scheduler.
9. Which are the commonly used shells used in Unix?
10. Display your current working directory.

11. Create a file with a name of your choice and write the names of your friends in it (use cat command).

12. Display the above file (use cat command).

13. Create a subdirectory of your name and create 3 files of your choice. Put any dummy data into it. Now list all the files present in that directory.

14. Rename a file from the subdirectory to a name of your choice.

15. Delete the subdirectory you just created using the rm option.

16. Give a brief idea about the hierarchical file system of Unix.

17. Explain the different editors used in Unix. Which is widely used and why?

18. Create a file containing your bio-data using vi editor and try out all the options given to you in this session.

19. How to find out the number of users logged into the system.

20. Define the different operational modes of the vi editor.

21. Explain the concept of filters in the Unix operating system.

22. Create a file of your own name. Enter a short story into it. Now using 'we' and its options count the characters, words and lines in the given file.

23. Using grep see if a particular word is there in the above file you made.

24. In the above file also find all the lines which

    a) begin with a vowel.

    b) do not begin with a vowel.

    c) lines that end with a pattern of your choice.

25. Why is shell an important part of Unix operating system?

26. Create an interactive shell script, which will ask the name and age of the user and print it on the screen. (the user should enter his age and name)

27. Describe the various loops, case statement and conditional statements used in Unix.

28. Create a directory and make some files into it. Using the tar command create a backup of that directory.

29. What is the difference between Round Robin scheduling and Swapping? Explain in detail.

30. Explain the structure of a typical Unix file system.

31. "Communication in Unix Operating system plays a very important role". How can one user communicate with the other users on the Unix perform.

32. Explain the concept of Redirection and Pipes with the help of appropriate examples.

33. Why is the shell environment important to Unix Operating system.

34. Highlight the difference between:

    a) Common environment variables and system shell variables

    b) Local and Global shell variables

    c) Interactive and Batch modes of command interpretation.

35. With an example, explain briefly how can words be separated from each other.

36. How can a person become a super user on the Unix platform?

37. What is the difference between the regular file and the device file? How does the kernel distinguishes between them?

38. Explain the difference between the multi-user mode and single user mode.

39. What use can the crontab file be to a Unix user?

40. Explain the stops in creating, mounting and unmounting a file system?

41. What is the importance of sync command in the unmounting of the file system?

42. Add a user "user 20" to the system. Assign it a password. Explain each step involved in the above process.

43. Remove the user created in Q. 42.

44. Explain the concept of default attributes.

Chapter 12: WINDOWS 95/98

Windows 95 Operating System was developed by Microsoft, by integrating the DOS and Windows features in order to give a user-friendly environment. All applications running under this environment essentially use similar operations thereby ensuring that the user is comfortable in the basic handling of all applications. The productivity, thus, goes up appreciably and the ease to master and use features of the Operating System leads to lesser reliance on technicians.

STARTING WINDOWS 95/98

1. Windows 95 or 98 is first loaded on to the hard disk of your computer using either floppies or CD's. The loading is achieved by using the SETUP command and the user can easily perform the consequent actions by following the instructions that appear on the screen.

2. Windows 95 requires atleast 8 MB of RAM while Windows 98 requires 16 MB RAM.

3. For starting operations, switch on your computer and Windows will be loaded and you will see a taskbar as shown below. By default this taskbar appears at the bottom of the screen. Above that the icons (graphical representations of tasks that can be executed by point and click of the mouse) appear.

Note the Start button on the left corner. In order to start our Windows session, click on this button. A menu as shown in the screen on next page will appear. The groups as indicated in the menu will do the following tasks:

1. Programs: Displays a list of programs you can start.

2. Documents: Displays a list of documents you have opened previously.

3. Settings: Displays a list of system components for which you can change the settings.

4. Find: Enables you to find a folder, file, shared computer or mail message.

5. Help: Starts Help. You can then use the help contents, index or other tabs to find out how to do a task in windows.

6. Shut down: Shuts down or restarts your computer or logs you off.

Each part of the start menu is discussed briefly in the chapter. Depending on your computer and options you have chosen, you may see additional items on your menu.

The part of the taskbar where you see a clock and some other symbols is known as the notification area. If you want to change the time or date of the computer take the cursor over the clock and double click. You will get a menu from which you can perform these tasks.

MOVING IN MENUS

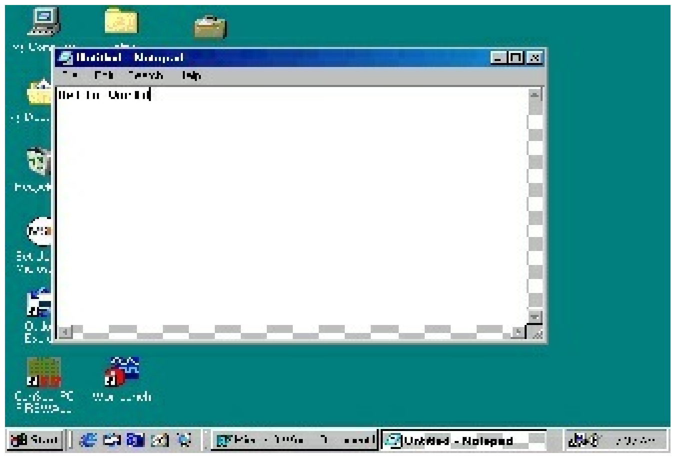
When you move your cursor to the programs icon from the start menu you, will see another pop-up menu opening up. This menu is known as the sub menu of the start menu. You can have any number of sub menus in this menu or any menu. You will notice a black arrow directed towards the right of any folder that contains another menu of folders or programs.

Any icon on these menus without a right arrow indicates that the program is executable i.e., it can run by itself or under an application installed in the computer or that is a part of the program.

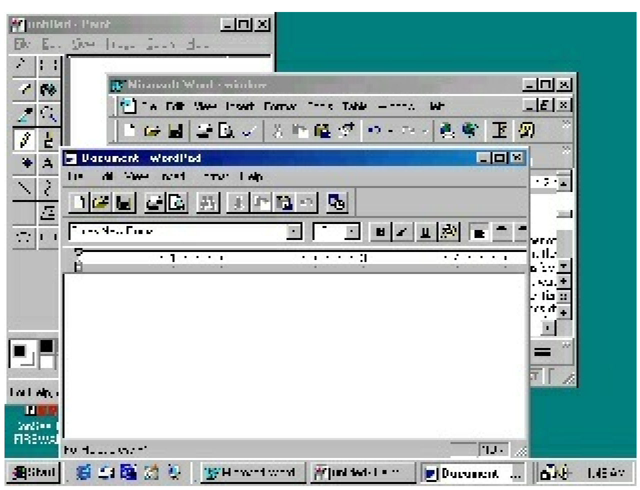
Whenever you open a program it starts under a window. On the top right corner of this window you will see a '–' sign, a '**x**' sign and another sign showing one or two windows.

The **'–'** sign minimizes the window to a button on the taskbar. This does not mean that the program is closed, it is just not being seen on the main screen. The program can be restored back by clicking on the button on the taskbar. The second button on this menu maximizes the window running the program. If the program window is already maximized it shifts the window to custom size (which can be adjusted).

The **'x'** sign when pressed exits the program and returns to the previous screen.

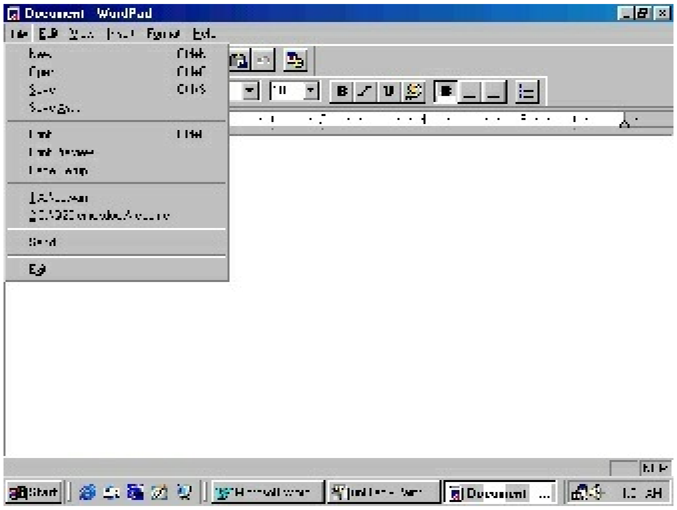


One of the main features of windows is that you can start any number of programs at one time which depends on the RAM (Random Access Memory) of the computer. You can switch between the programs by just pressing on the buttons the program on the taskbar. The clicked program window appears over the previous window. You can work on only one program at a time. The active window is represented by a colored top bar and the nonactive programs by discolored top bar. If the nonactive program is visible on the screen as shown in figure it can be made active by simply clicking on any part of it; its window comes over the previously active window.



Working with documents or files.

1. To make a new file go on the file menu and press new.

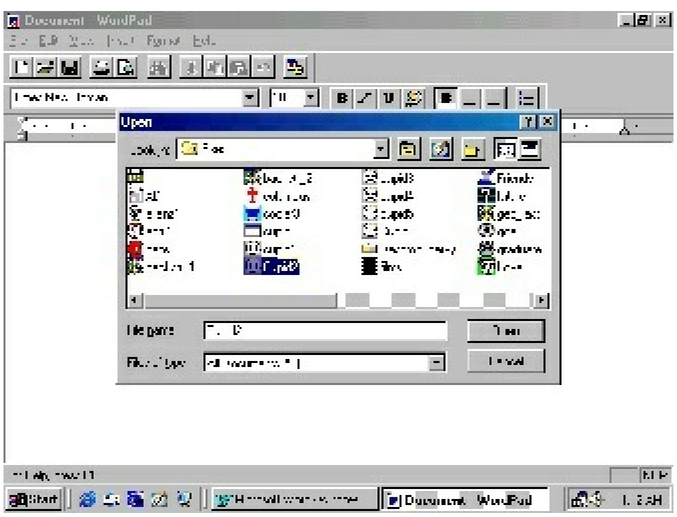


2. To open a file in a program go to the file menu and click on the open button. This opens a menu.

3. Look in shows the folder whose files are being shown currently. You can change the folder by clicking on the menu of look in.

4. To the right of look in is an icon showing a folder and a bent arrow facing upwards. This button moves the folder where the files are to be looked up by one level i.e., to its main folder.

5. Files of type menu on the bottom indicate what all the files with respective extensions which can be opened by that particular application.

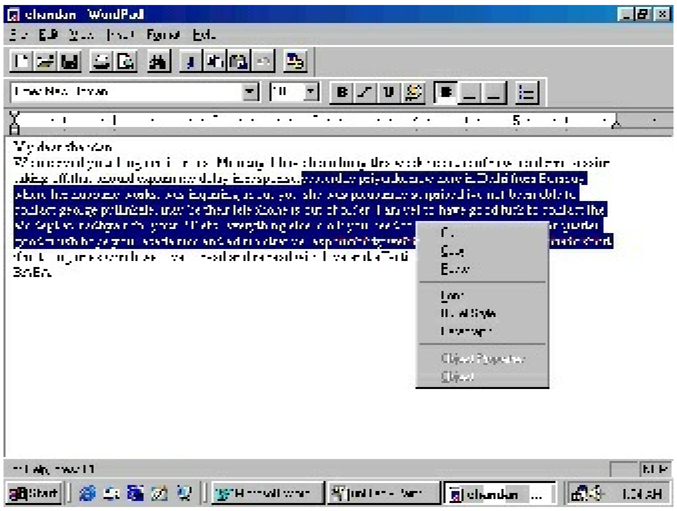


6. To save a file go to the file menu and press save as. The computer will indicate you to give a name to the file and then save it. If some changes are made to a saved file you can save them again by just clicking on save from the file menu.

7. To print a file go to the file menu and click on print. Only if the printer is properly configured with the computer software will it start printing the document otherwise it will show an error.

8. In the edit menu cut, copy and paste options allow you to cut and paste or copy and paste any part of the document selected with the mouse. To select a portion under a document, at move the cursor to the start of the portion and by clicking the left button drag the mouse over the portion to be selected which will then be highlighted. Then you can perform various tasks such as cut, copy, delete, change fonts etc., with it.

9. To close a file press close from the file menu.



UNDERSTANDING THE START MENUS

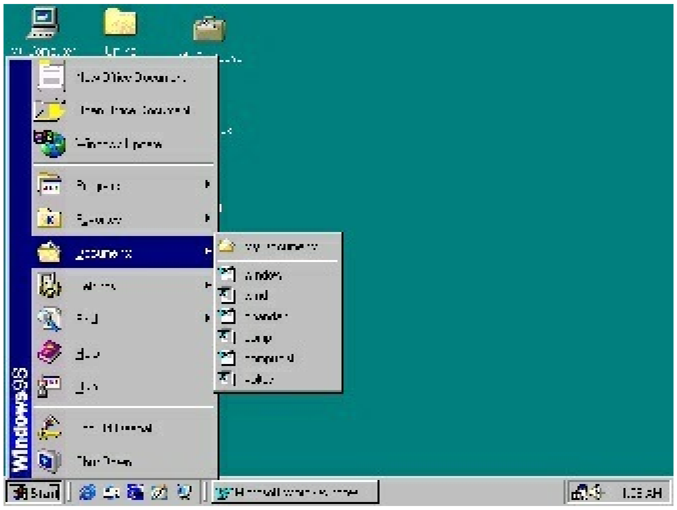
Program Menu

Program menu contains a list of folders and applications, which are installed on your computer. As previously discussed, a program menu has a lot of folders which open further sub menus. The executable programs are usually represented by a symbol alongwith their names and can be started by clicking on it once.

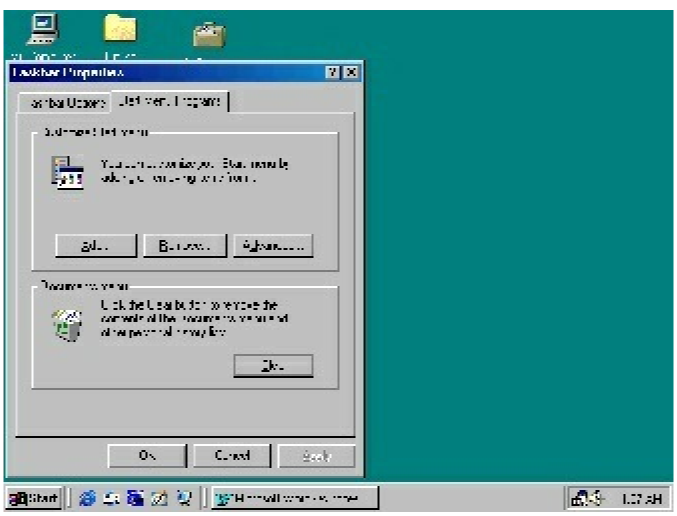
To rename or delete an icon on the menu take your cursor to the icon and right click the mouse you will see a menu from which you can do so.

Documents Menu

It contains a list of documents that run under window application packages. It shows a maximum of fifteen previously opened documents. The documents in the list can be started by clicking on them once. Thus the document menu can saves a lot of time by making it easy for you to open some of the unfinished documents you want to work on again or make changes in them later.



To remove the complete list from the documents menu go on the taskbar and start menu icon from the settings icon. When the window is opened go on the start menu tab. In the start menu tab in documents menu press the clear button. This removes the list of documents in the documents menu.

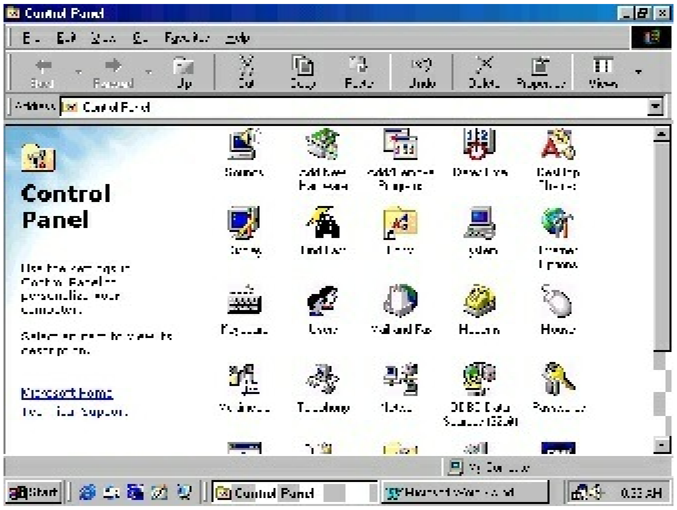


Setting Menu

The setting menu displays a list of system properties whose settings you can change. The settings menu consists mainly of Control Panel, Printers & taskbar and Start menu programs.

Control Panel

To start control panel just click on it from the settings menu.

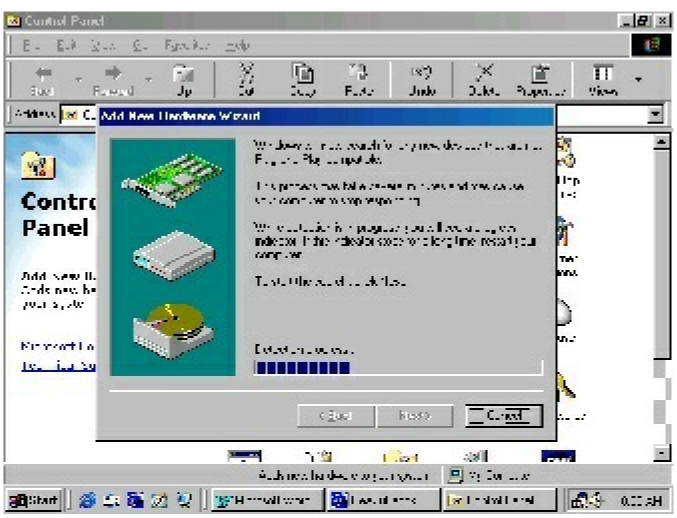


Using control panel you can change the way windows looks and works. It contains a list of icons through which you can change your screen colors, install or change settings of hardware and software setup or change settings for networks, printers, mail, fax and modems etc.

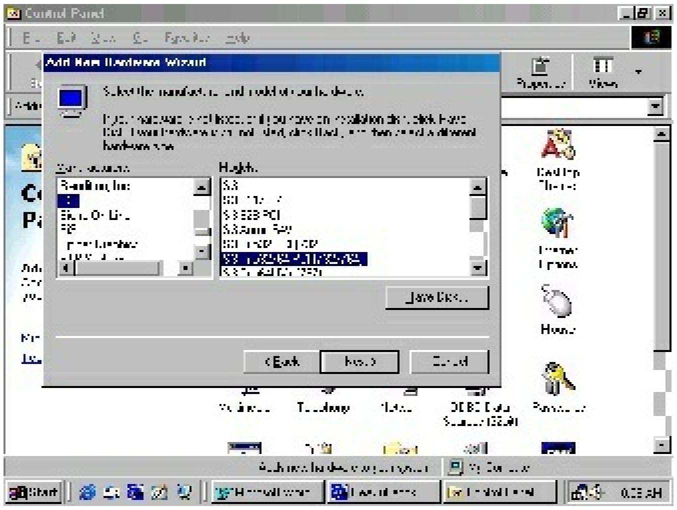
The icons that appear in control panel varies depending on the hardware and software installed on your computer.

Some of the important icons of the control panel are discussed below.

1. Add new hardware: Helps you in installing any new hardware you wish to include in addition to existing hardware in the computer. Just follow the instructions the appear on the screen to install the hardware properly.

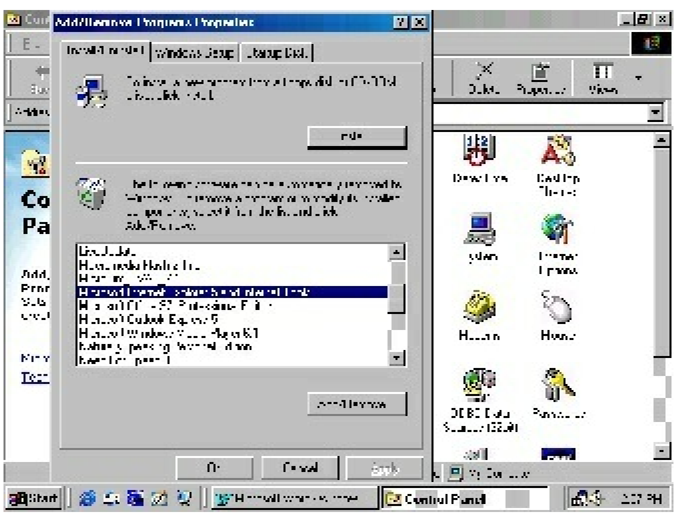


If the hardware is not detected by windows automatically you can also select it manually from a list of hardware devices, which appear on the screen. You can also do the installation by using the disc provided by the manufacturer by pressing have disk column on the screen.



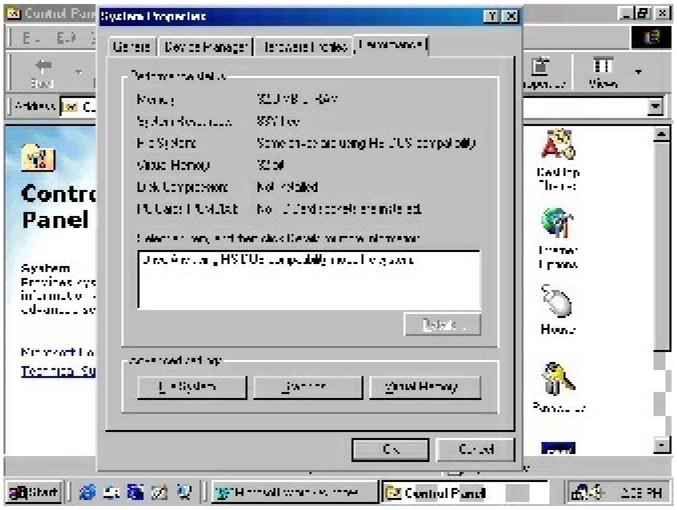
2. Add/Remove programs: Sets up programs, i.e., it helps in adding or removing any program in Windows. In the add/remove properties there is a list of all the applications and programs installed in Windows on the machine. You can install more programs from here or remove the programs already installed on the computer.

   It is very important to uninstall programs installed in Windows. Simply by deleting the files of the folder in which the program is installed does not remove all components of the program. Thus proper uninstallation should be performed to completely remove the application.

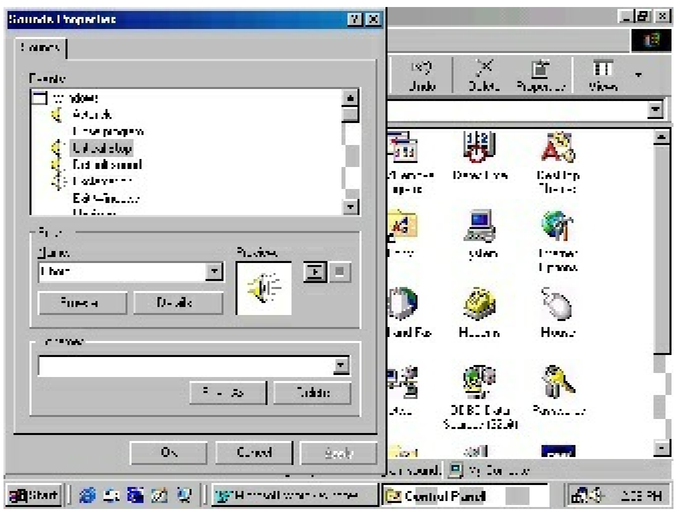


3. Display: Through this you can adjust the display settings of your computer. It also helps in changing the way window looks on the screen. You can add backgrounds to your desktop, put screensavers which start if the computer is left idle for a given time and change the appearance of windows using various options. The settings tab in the display menu helps you in adjusting the color scheme, the screen size, monitor properties, display card and other advanced settings.

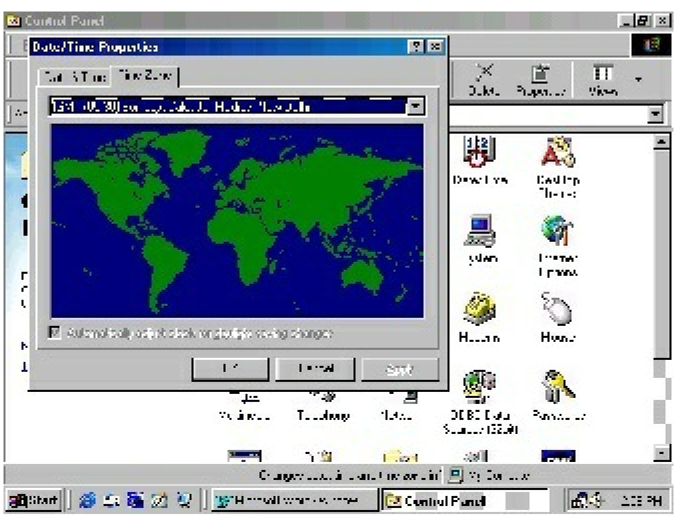
4. System: It provides system information and changes advanced settings.



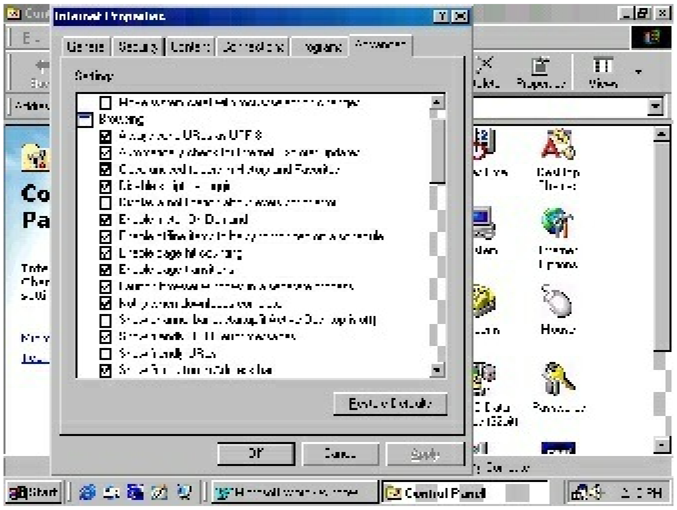
5. Sounds: Changes system and program sounds.



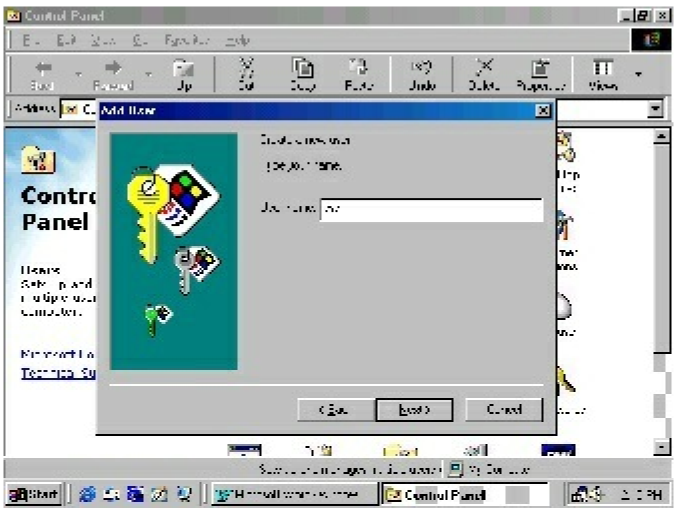
6. Date/Time settings: Changes date, time and time zone settings.



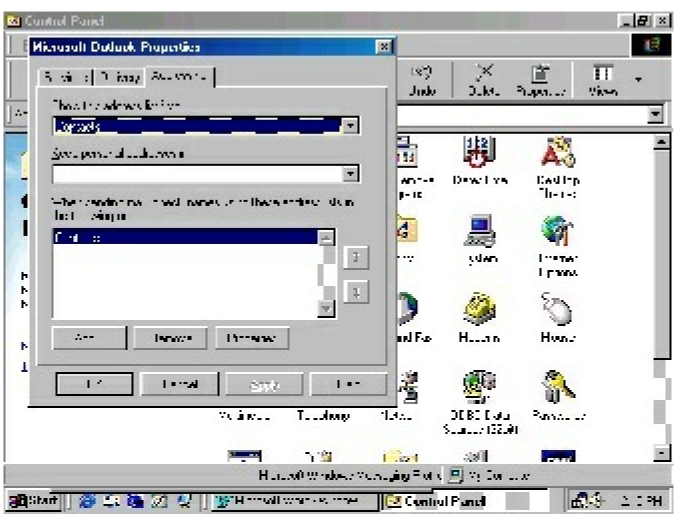
7. Internet settings: Changes settings of Internet to work with the Internet Explorer browser.



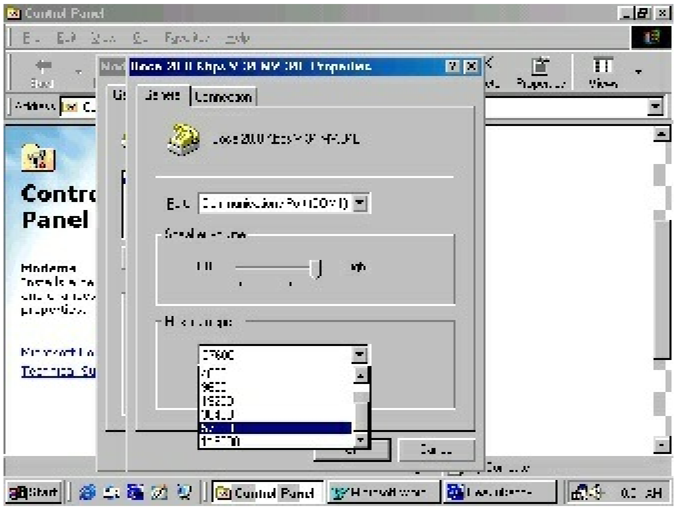
8. Users (not in win95): Helps you manage multiple users.



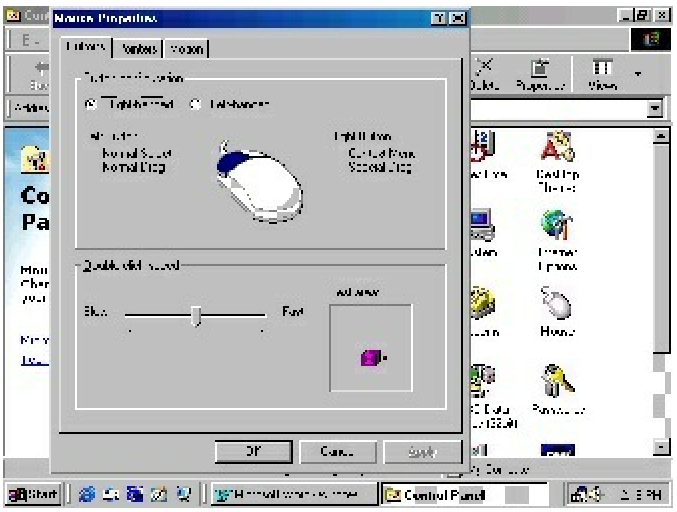
9. Mail and Fax: Set up or make changes to your computer mail and fax accounts.



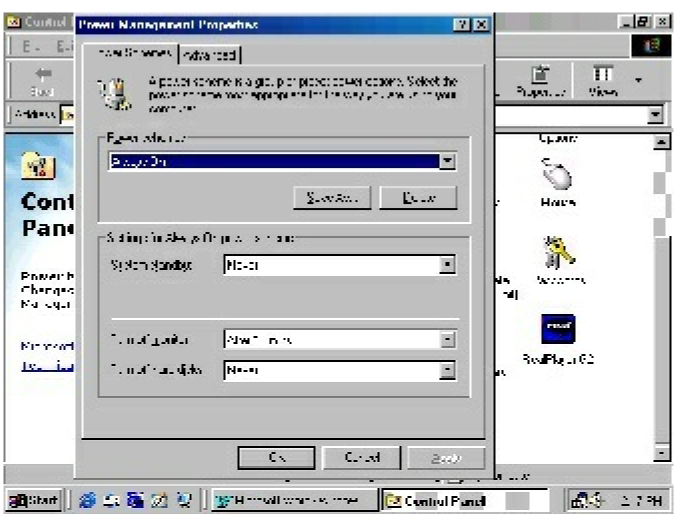
10. Modems: Allows you to setup a new modem or change various simple and advanced properties of an already installed modem.



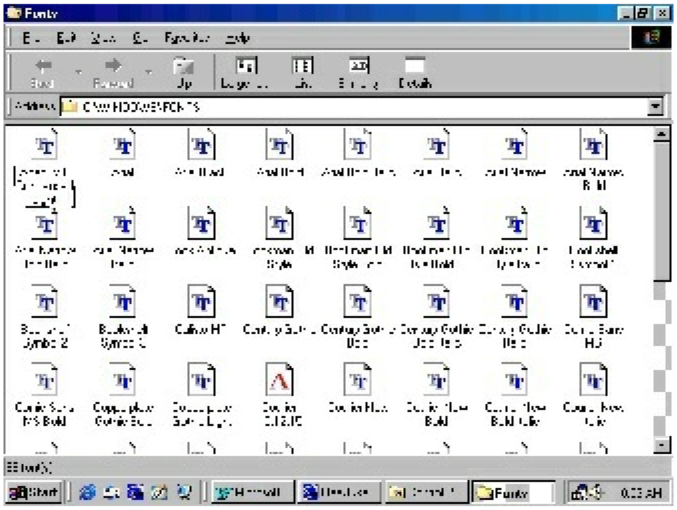
11. Mouse: Changes settings for mouse.



12. Power management: Helps in managing implementing various power schemes on your computer.

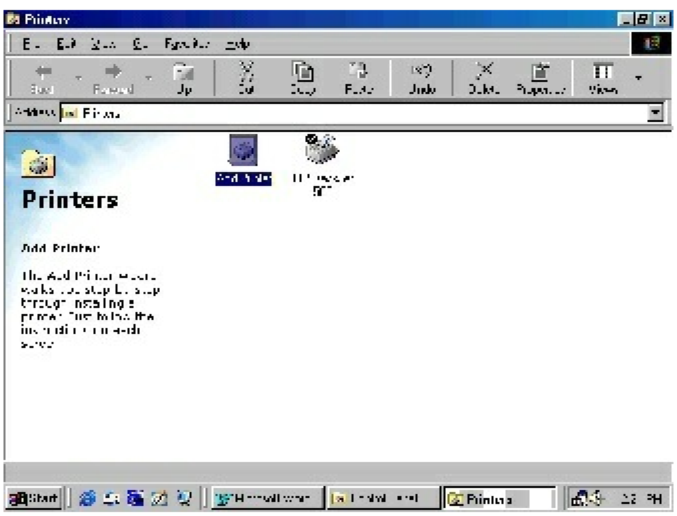


13. Fonts: Shows the user various font schemes available under windows.



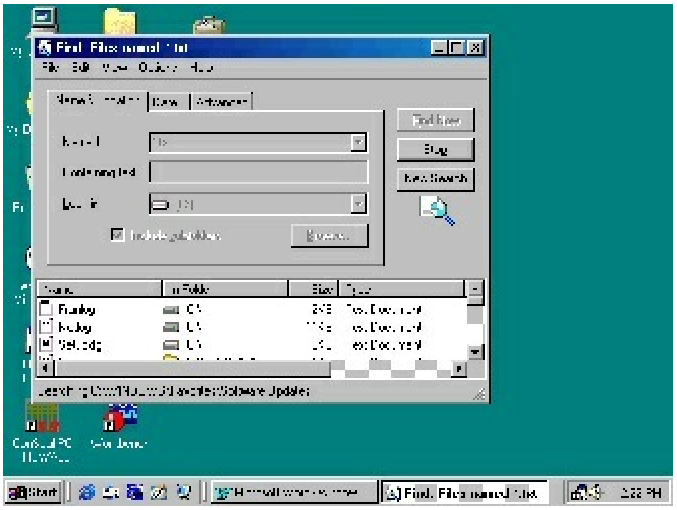
Printers

To install a printer click on printers from the setting menu. The screen shows list of printers already attached to the computer. To install a new printer double click on column add printer and follow the instructions on the screen.



Find Menu

It helps in finding any files or folders located in the computer or a network. Other options also allow you to find any users on a network or search the Internet for information.

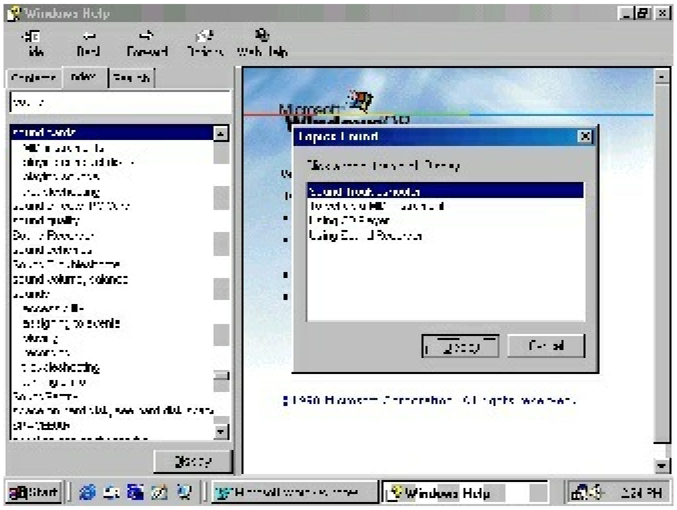


Run

Its main purpose is to open an executable program located in the computer or a network by giving its exact location on the open line. Old programs running on MS-DOS can be started properly using the Run command.

Help

Starts help manual for windows. It helps the user by explaining in detail how a task is to be performed under windows. To look for a specific topic the user can use utilities like contents index and find under the help program.



Shut Down

It shuts down the computer i.e. it closes all programs running currently, does a system check and then displays a message to the user to shut down the computer.

It is very important to perform a proper shut down before turning off your computer otherwise files or system resources could be affected.

The shut down menu also allows you to restart the computer or log off your computer from a network if present.

Explorer

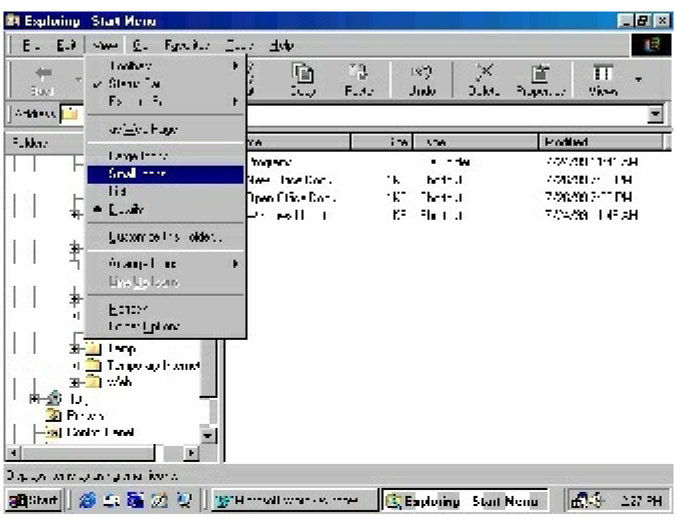
To manage all the files and folders in your computer windows has a program called windows explorer. It can be started from the program menu or by right clicking on the start menu and then clicking on explore on the menu that appears.

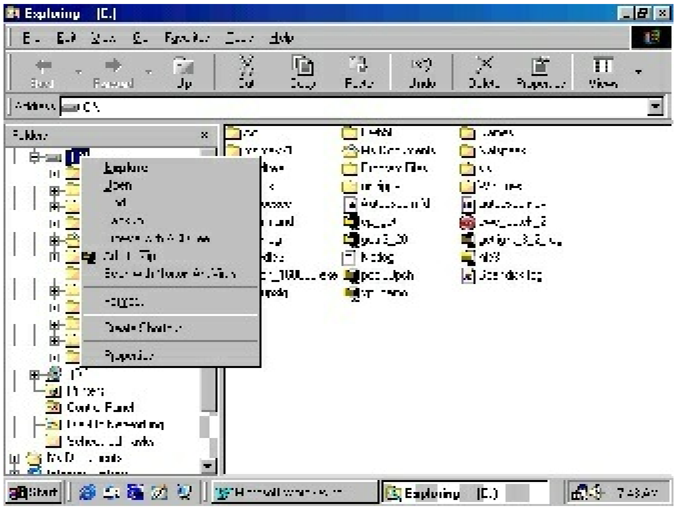
Folder

A folder also known as a directory contains files and other sub folders in an order. It helps in keeping things organized on your computer.

On the left screen is a list of folders you can explore. The '+' sign before any folder indicates that the folder is expandable i.e. it has more sub folders under it. When you click on a specific folder its contents i.e. files and sub folders under it are displayed on the right of the screen.

You can change the way icons look by going to the view menu and clicking on the various options available.





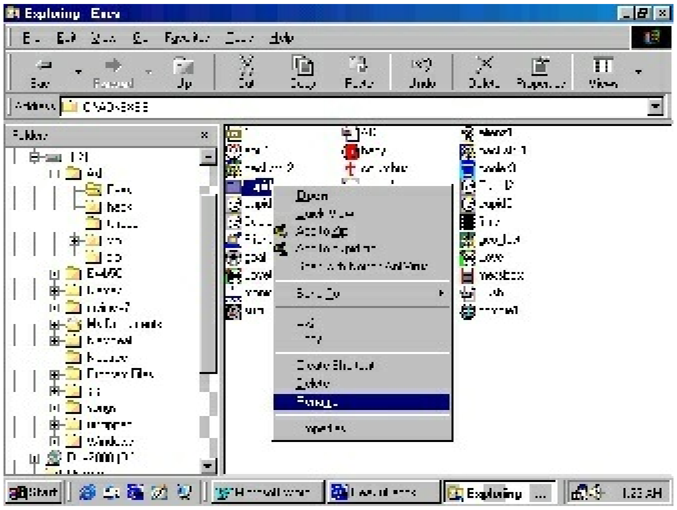
To open a specific menu for a file or folder right click on the item. A menu appears which helps you in performing various tasks on the file or folder. We will look in detail on how to go about various tasks in explorer.

1. Cutting files or folders removes them from their original location and moves all of its contents to the new location specified.

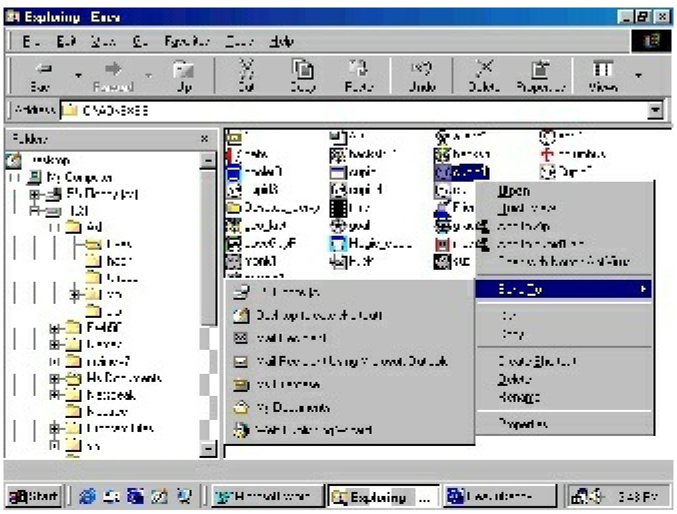
2. Copying files or folders keeps them in their original location and makes a copy of its contents on the new location specified.

3. Deleting files or folders removes them from windows explorer. Note that in windows the deleted files go into the recycle bin. This means that the files are not really removed from the hard disk but just are not being seen. The main purpose of this is that the user can restore the files accidentally deleted by him from the recycle bin. To completely remove the files you have to empty the recycle bin whose icon is visible on the desktop. Another easy method to delete the files or folders directly is to press shift + delete. Now the files do not go to the recycle bin but are erased completely from the computer.

4. Select the file or folder by simply clicking on it. To select multiple files press shift and move the cursor over the name of the files. To select all files under a folder press ctrl + A.



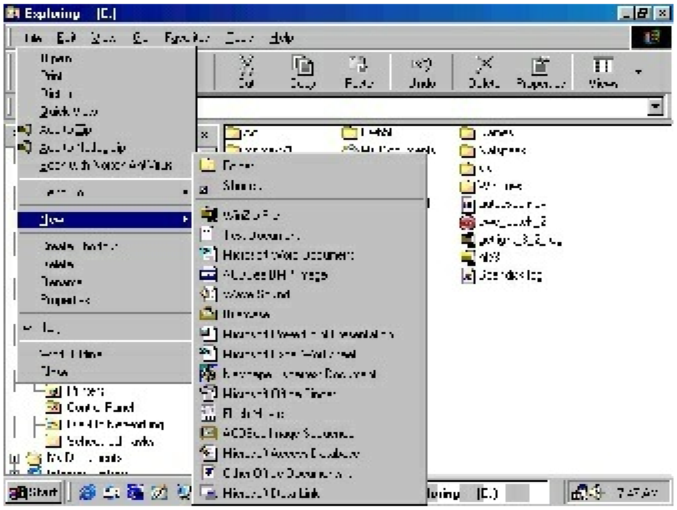
5. When the file(s) is selected right click on the mouse button to see a menu from which you can select if you want to cut, copy or delete the file(s) or folder. You can also perform the task by going to the edit menu and selecting any of the task you want to perform on the file(s) or folder.



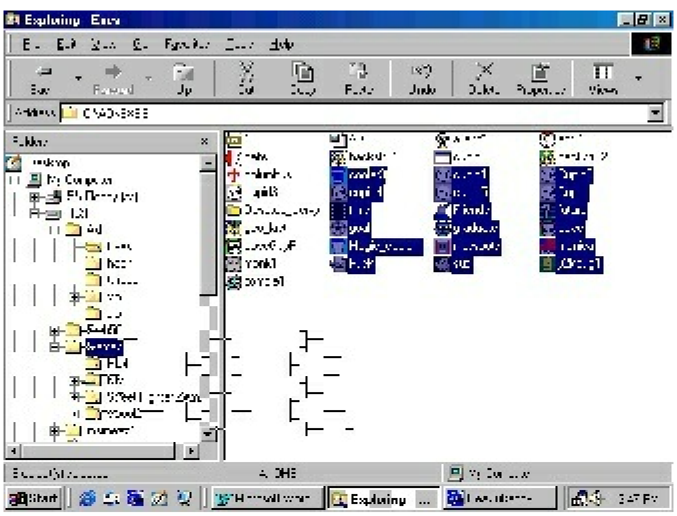
6. To paste the file(s) or folder select the location where they are to be placed and then press paste from the edit menu.

7. The menu that appears on right clicking the selected file(s) or folders also allows the user to send the selected file(s) or folders to various places on the computer like floppy (A:), desktop (creates a shortcut to the program on the desktop) or in the mail program directly.

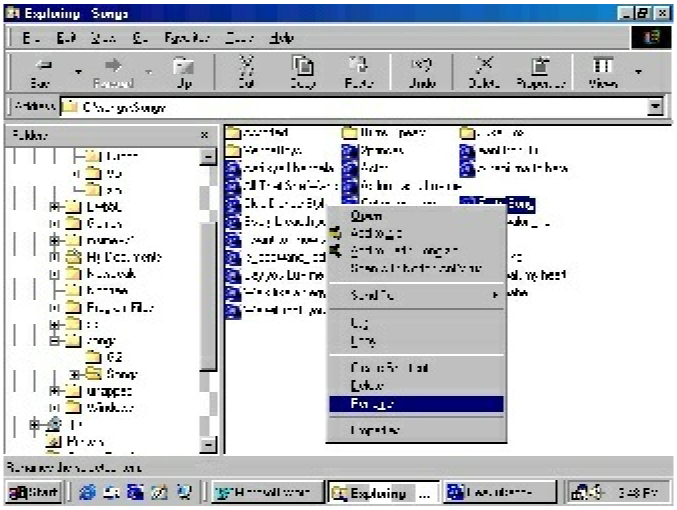
8. To create a new folder first select the drive or folder in which you want to place the folder. Then go to the file menu, point to new and then click folder. Type the name of the folder and press enter key.



9. To move files or folder directly from one place to another simply left click on it and keeping the mouse button clicked move it to the new location visible on the screen and then leave the mouse button. This is known as drag and drop method. In this all files or folders are moved to a new location on the same drive and are now not available in its previous place. The limitations of this is that both the locations, i.e., old and new must be visible on the screen or could be reached without leaving the mouse button. Note that dragging a file between two drives copies it to the new drive instead of moving it.

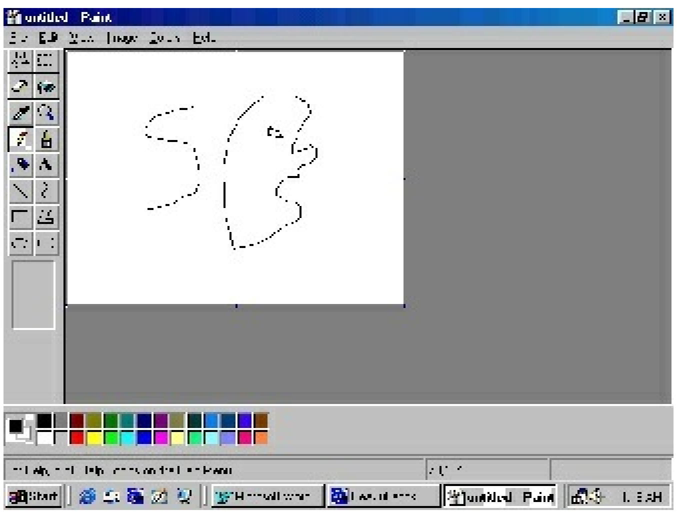


10. To rename a file or folder first select it. Then go to the file menu and click on rename. Enter the new name and press enter. The user can also select the rename option under the Right click menu of the selected file or folder and change the name.



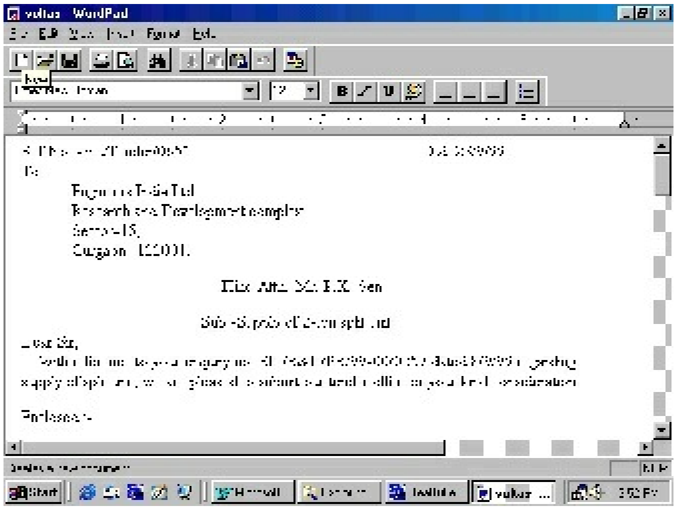
CREATE PICTURES USING PAINT

You can create your own free hand drawing and fill colors in it using Microsoft Windows paint program. It can be started from the accessories menu in the program menu. You can cut & paste these pictures under documents or on the background of your computer.

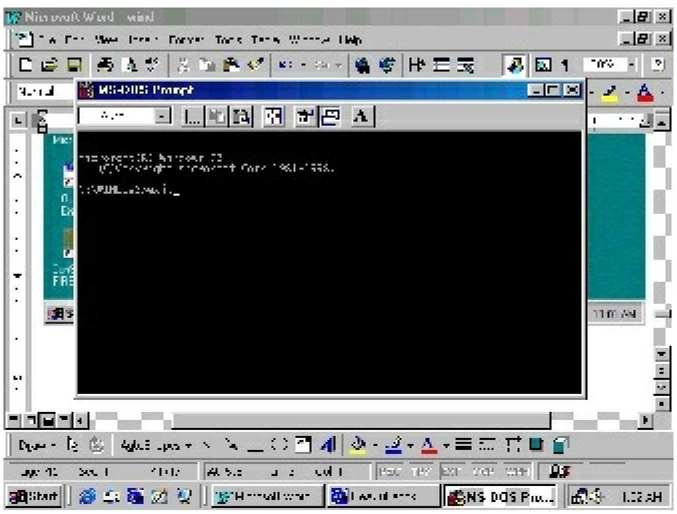


WRITING DOCUMENTS USING WORDPAD

You can write all you letters, documents, etc., using the wordpad program. It can be started from the accessories menu in the program menu. It includes features such as cut, copy, paste, find and fonts to make your work easier and more presentable.



MS-DOS PROMPT



Old die hard DOS fans would not be disappointed in using windows. Windows provides a fully compatible DOS interface. You can run all your DOS programs from here as well and execute most of the DOS commands for performing various tasks. To get out from the DOS environment and return to windows just type exit from wherever you are.

REVISION EXERCISES

1. Describe the functions performed by an Operating System?
2. What is the function of a Task Bar?
3. What are:
   (a) Screen Savers
   (b) Recycle Bin?
4. What is meant by accessories?

5. Explain the functions of Windows Explorer in detail.
6. Describe the functions of the Control Panel.

Chapter 13: MICROSOFT OFFICE

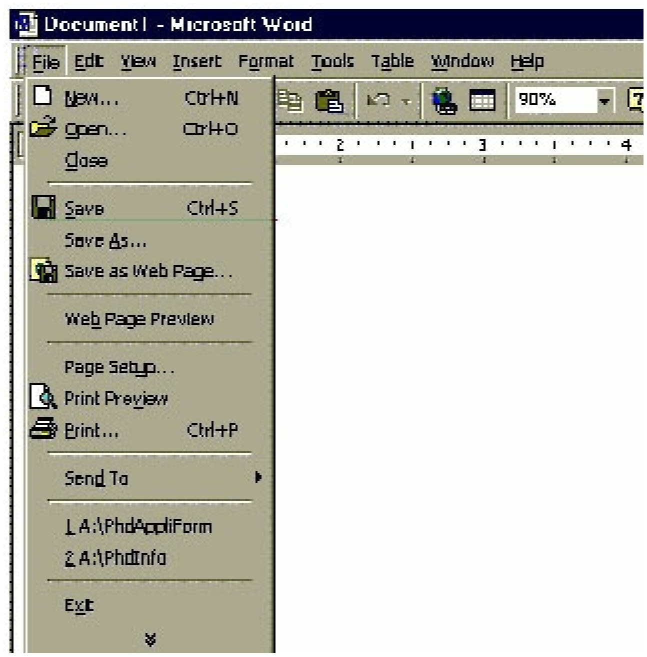
MS WORD

MS Word is Microsoft's solution to meet the word processing needs of everyone. Like any other word processor, this package also contains necessary typing, editing and aesthetic features. In addition to these features, MS Word also provides great tools for specialized word processing applications.

We will now cover the important features of MS Word in the following sections/paragraphs:

Creating Word Documents

Primarily a document is created by using either the File>New command or by choosing New Document in the Programs menu. This will present us with a screen stating that Document1 has been opened and is ready to be written into. The File menu alongwith the Word window will look as under:



You can start entering text in the blank window presented, keeping in mind not to press the Enter key before the paragraph ends. Once the typing is over, the next step obviously is to ascertain if any typing mistakes have crept in. If there are, editing (correction of the text in this case) involves the placement of the cursor at the affected letter/word through either clicking the mouse at that location or using the arrow keys to bring the cursor at the required place.

After having positioned the cursor, pressing the del key and retyping (if required) will make the correction.

Keep in mind that the Office Assistant feature in Word 2000 keeps track of what you are doing and keeps on offering suggestions. The Auto Correct feature automatically corrects certain misspelled words and the spelling and grammar feature reviews your text to determine spelling and/or grammatical mistakes.

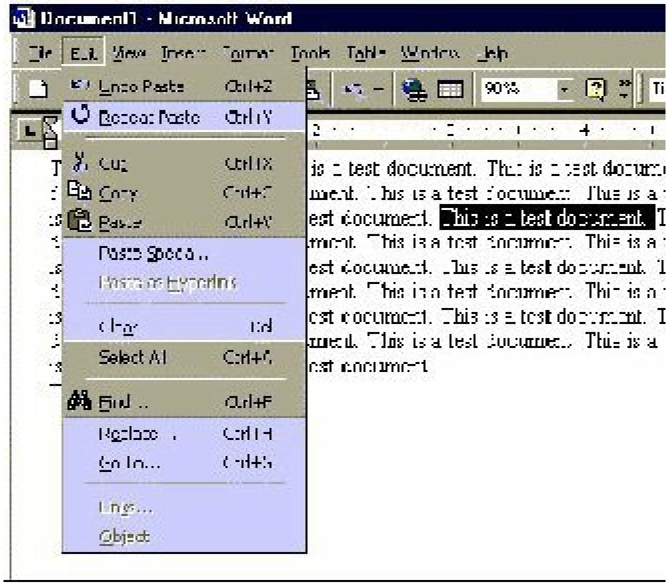
Also note that by pressing Ctrl+Backspace and Ctrl+del complete words would be deleted.

Editing Text (Advanced Features)

The screen below shows the Edit menu which can be invoked and has several features which demand that the text you wish to edit should be selected first. Selection normally is indicated by the text being highlighted by a black background.

Text can be highlighted (or selected) through various methods available:

1. Bring your cursor to the beginning of the text you wish to select. Right click and drag your mouse till the end of the text you have selected.
2. Through arrow keys bring your cursor to the beginning of the text. Hold the Shift key pressed down and at the same time, select the text through the use of the arrow keys.
3. A word can be selected by double clicking on it.
4. A sentence can be selected by holding the ctrl key and clicking anywhere in the sentence.
5. A paragraph can be selected by triple clicking anywhere in the paragraph.
6. An entire document can be selected by Edit> Select All from the menu bar or by holding the Ctrl key and clicking in the left margin.



Copying, Cutting and Pasting Text

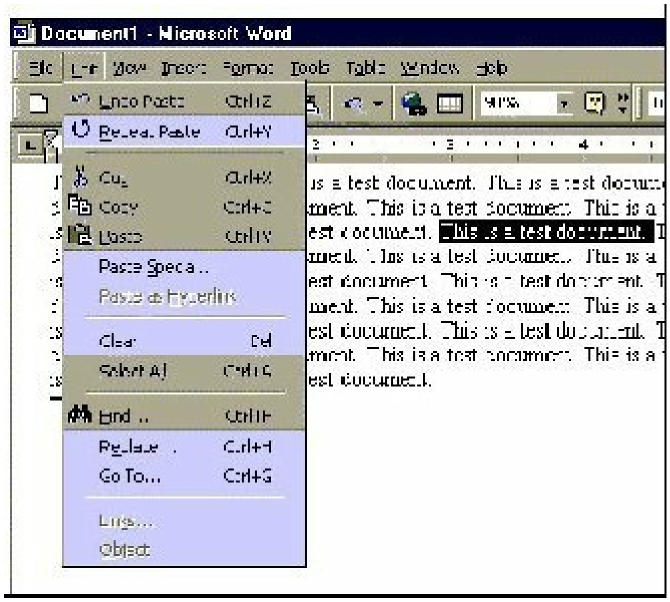
Many a times, in the course of document production, it becomes necessary to move portions of text from one location in the document to another. In order to achieve this, the text to be moved is selected (highlighted) and then copied to the windows clipboard by using the Edit > Cut command.

In order to bring this cut portion to the location where it has to be moved, the cursor is first brought to that location and then the Edit > Paste command will paste the cut text from the clipboard.

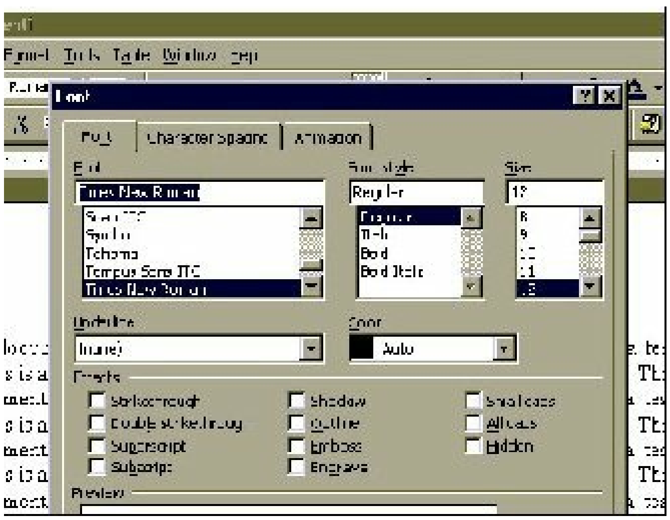
The Edit > Copy command differs from the Edit > Cut command in the sense that whereas in the Cut operation the text is removed, in the copy operation the text is copied to the clipboard but also remains where it was in the document.

Formatting and Aligning Text

It is important for a document to be presented to the reader in such a manner that he is attracted into read the contents. One major beautification component lies in formatting text: the selected portion of the text can be made to have a different font (remember Font consists of typeface, size, style, etc., amongst other qualities). The format menu reproduced below shows various formatting options:

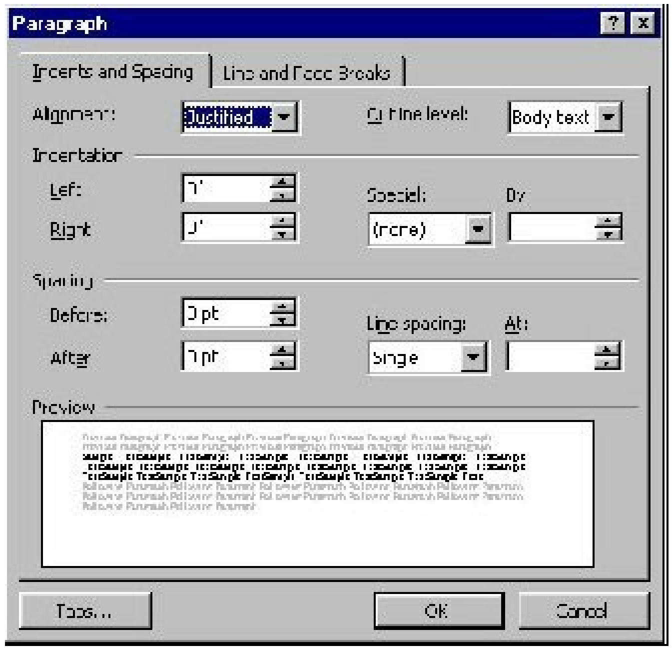


Pressing the Font command for the highlighted text gives rise to a dialog box asking for more information as shown under (note colour, underline, superscript, subscript, etc., are all decided and applied to the highlighted text here):



The next important feature required for the document to look good is the alignment of the left and right margins. This is achieved by selecting the paragraph and then applying, left aligned, right aligned, centered or justified feature through the Format>Paragraph command as shown in an earlier menu. This can also be applied by the shortcut icons as shown under:

Indenting your paragraph and adding special properties to it is achieved by pressing Format> Paragraph and then setting the properties in the dialog box presented as shown under:

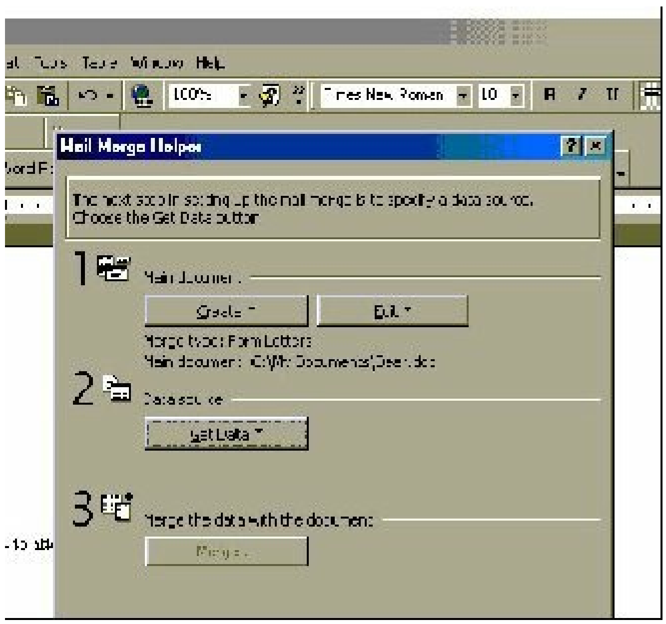


Special effects like bulleting your text, adding borders, giving a background shade to your documents is easily achievable by the Format> Bullets and Numbering or Format> Borders & Shadings features. Further features of small case/uppercase or drop a capital are also present in the Format menu.

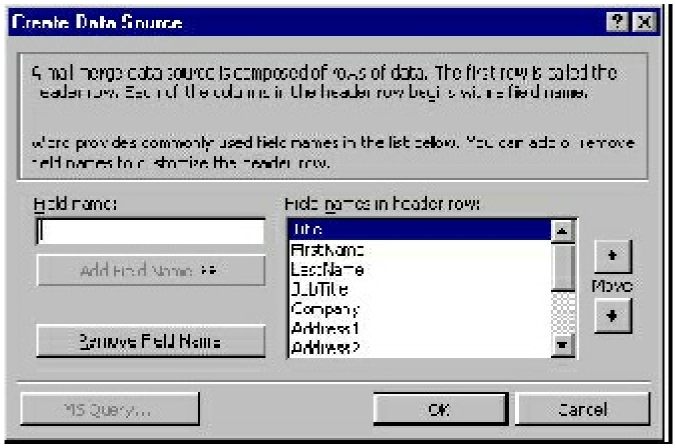
The Mail Merge Feature

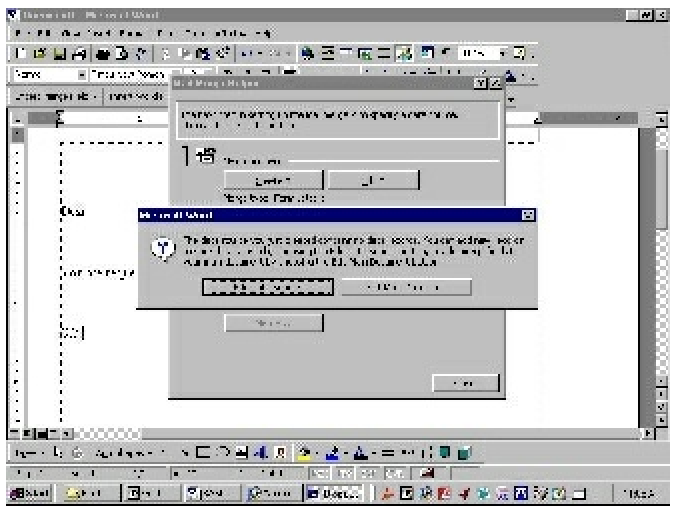
One of the very powerful feature of MS Word is its ability to send original letters to different people through the production of a single common document and the merging of this document with a data file containing data relevant to each recipient of the letter. For example if an interview letter has to be sent to various candidates asking them to appear on different dates and times for different positions, a single document will be typed in which the name of the candidate, address, time, date and position for which being interviewed will be left blank.

As a second step, another document known as data document would be created using the Tools > Mail Merge command which will present us with the following dialog box:



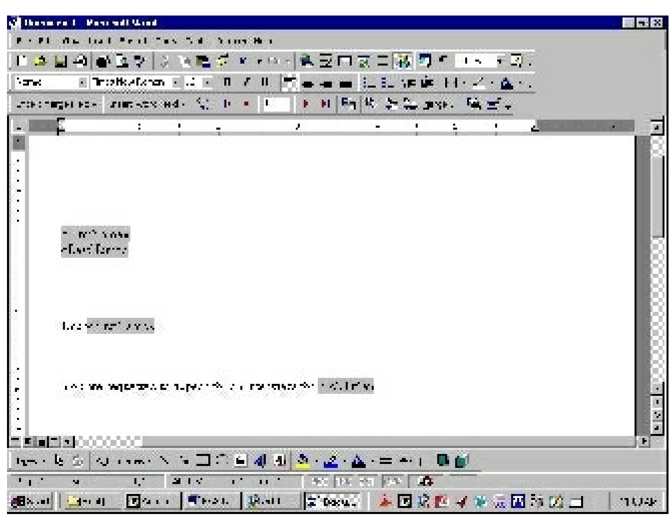
Pressing the Get Data button will present us with another dialog box where we will be at liberty to choose amongst predefined fields, delete those fields and add our fields. Since we require first name, last name , position ,time and date of interview we will only create /select those fields in order to create our data entry form. The dialog box is as presented below:





Pressing Edit Data Source will present us with a data entry screen in which the details of all candidates can be entered.

The final step will be to insert relevant fields in the main document by choosing Insert Field from the main document window and inserting at appropriate places by clicking the mouse at that location where you want the data to be inserted from the data document. The main window screen and inserted fields will look as under:



At this stage, go to Tools>Mail Merge and press the merge button in the dialog box.

Individual copies of the letter for each candidate will be created/printed.

Tables

Another innovative feature of MS Word is its ability to create tables with user specified rows and columns. This is achieved through the Table menu which is shown as under:

- Click insert table on the standard toolbar and specify the number of rows and columns.
- You can use the AutoFormat feature to give your table a variety of borders and fonts.
- Columns to the Left and Columns to the Right will insert columns to the left and right in the table. Similarly Rows Above and Rows Below will insert rows above and below the Specified row. Using Cells feature you can add an entire row, column and shift a cell to the right and down.

Another facility under the Table menu is that you can delete the entire table or a particular cell, row, column or multiple rows and columns.

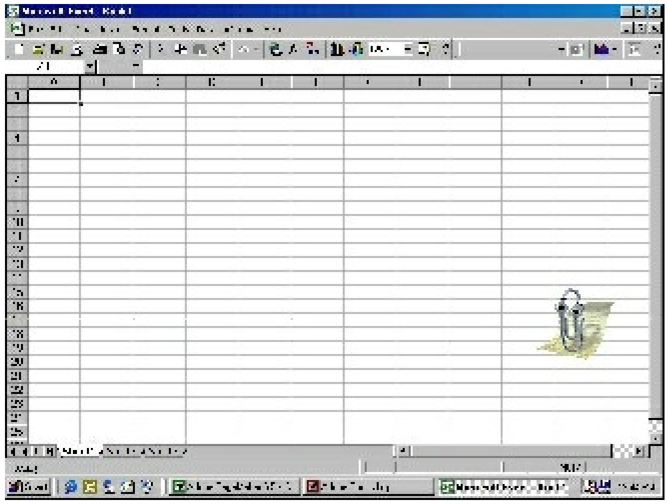
MS EXCEL

Creating Worksheets and Entering Data

Excel is a spreadsheet program that you can use to enter, manipulate and work on data to your heart's content. Excel is mainly used for large data and calculations, etc., as it is a program designed to work with numbers .You enter your data in cells arrayed into horizontal rows and vertical columns on a worksheet.

Excel organizes worksheet by workbook on the basis that you may need more than one worksheet for any given project. Each new workbook you open contains three worksheets by default but you can add worksheets upto a maximum of 255. Each worksheet contains 65536 rows and 256 columns. Rows are numbered from 1 to 65536 and columns are numbered from A to IV (the first 26 columns are numbered A to Z, the next 26 AA to AZ, the next 26 BA to BZ etc.). The worksheets are numbered from 1 to 256 but they can be also given names to suit the requirement.

When you launch Excel, the Excel application window opens with a new Excel workbook. The title bar and command bar are at the top of the window. Below the command bars is a strip that contains the name box and formula bar. The status bar displays current selections, commands or operations.



A cell is the interaction of a row and a column. Each cell has a unique address composed of the cell's column and row. The cell in the top left corner of the worksheet is cell A1. The active cell is identified by a dark outline called the cell pointer and the headings in the active cell are out-dented or " lit-up". When you enter data, it is always placed in the active cell. Application window of Excel consists of the following.

Create/Open Workbook

Select the New. Command from the File menu. The workbook is opened by the default name of Book1.

To open an existing workbook, select Open option from the File menu.

Save Workbook

To give a name and save the workbook:

- Choose File→Save As→command

To simply save the workbook

- Choose File→Save→command

Types of Data in Excel

Excel recognizes five types of data: Numbers, Date, Time, Text and Formulas.

Numbers

Numbers are values that can be calculated. They can consist of the numerals 0 through 9, with a decimal point as a separator for decimal places and with commas as separators for thousands. Numbers can start with a dollar sign ($), or with a + or – sign. They can end with a % sign; they can also be enclosed in parenthesis.

Dates

Excel handles dates as serial numbers and represents them in the following four formats:

Date Format	Examples
MM/DD/YY	07/10/01
MMM-YY	Jul-01
DD-MMM-YY	10-Jul-01
DD-MMM	10 –Jul

Times

Excel uses serial numbers for times as well, representing the 24 hours of the day as values between 0 and 1. It represents time in the following four formats:

Time Format	Examples
HH:MM	10:15
HH:MM:SS	22:15:17
HH: MMAM/PM	10:15 PM
HH:MM:SS AM/PM	10:15:17 PM

You can combine the date and time values to refer to a given time on a given day.

Date and Time Format	Example
MM/DD/YY HH:MM	10/07/01 10:15(AM/PM optional)
HH:MM MM/DD/YY	22:15 10-07-01

Formulas

Formulas are mathematical formulas telling Excel to perform calculations on data in cells. For example, to add the data in the cells A1, B1 and C3 and display the result in the cell D4, you would enter the formula +A1+B2+C3 in cell D4.

Text

Excel considers any data that it does not recognize as a number, date, time or formula to the text. It means that data containing letters will be treated as text. Text to long for the cell will be displayed in the cell to the right if empty; otherwise, only the part that fits in the cell will be displayed, though all of the text is stored.

Entering Data

To enter data in the active cell, first activate the cell and then begin typing the data. As soon as you begin entering characters from the keyboard,
three things happen; an insertion part appears in the cell, the text you are entering appears in the cell and the formula bar and formula bar button are activated.

Auto Fill

Auto fill feature lets you quickly enter predefined series of data such as data, text or number. After you have made one or two entries in the table, let Excel know what you are trying to enter in cells, drag the auto fill handle unto the point the data is to be entered.

For example for a series of numbers that increase by a given amount, enter the first two numbers in the first two cells like 1 in cell A1 and 2 in cell A2.

1. For a known text series such as month of the year enter the first text label. For example enter January in cell A1.
2. Select the cell or cells containing the information.
3. Click the auto fill handle in the lower right corner of the rightmost or lower cell and drop the resulting border across or down through the cells.

   The auto fill handle is in the small black square in the lower right corner of the cell.

EDITING AND FORMATTING A WORKBOOK

Editing Data

For editing data in a worksheet, first make the cell you want to edit active by clicking on it. Then press F2 or double click in the cell to enter edit mode which Excel will indicate by displaying Edit at the left end of the status bar. Excel will display the data from the cell in the reference area and will display a blinking insertion point in the cell at the point where the edit will take effect.

Copying and Moving Data

You can copy and move data in Excel by using Cut, Copy, and Paste (as in MS Word) or drag and drop. There are two points to be noted.

1. When pasting a range of data, you need to only select the upper left anchor cell of the destination.

2. To use drag and drop, select the cell or range to move or copy and then move the mouse pointer to one of its borders where the pointer changes from fat cross to an arrow. You can then drag and drop as usual. Watch the information box identifying the range in which the selection will land.

Delete

Select the cell or range and press Delete.

Working with Ranges

A range is one cell or many cells. It can be a rectangular block of cells or an irregular block of cells. Ranges can be named and they give you a way to work with a number of cells at once. The name box on the left end of the formula bar displays the name of the currently selected range.

Selecting a Range

To select a range of cells

- Click in the upper left cell of the range, hold down the shift and then click in the lower right cell of the range.

Or

- Click in the upper left cell of the range and drag to the lower right cell of the range.

Naming a Range

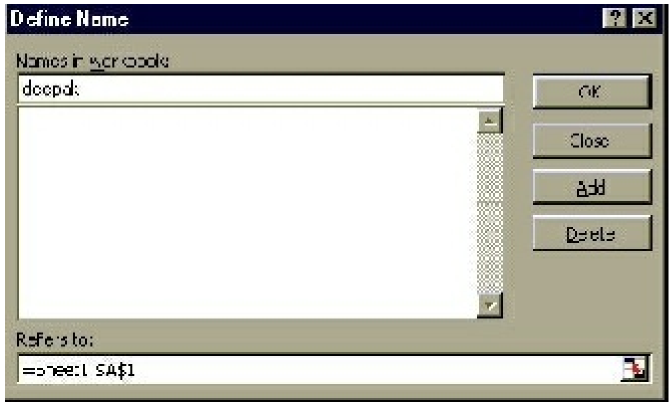
To name a range

- Select the cell or range.
- Click in the name, drop down list box at the end of the formula bar.
- Enter the name of the range – it can be upto 255 characters with no spaces and should start with a letter, a backslash or an underscore.
- Press enter.

Changing and Deleting Range Names

1. Select the range or cell.
2. Choose Insert ->Name -> Define to display the name dialog box (see fig.). You will find the names of ranges in the list box.
3. Add, change or delete the range name.
   - Type a new value for the range and click Add.

   - Reuse an existing range name by choosing it in the list box and click Add
   - Select the range name from the names in the workbook list and click delete.
   - Add, change or delete further range of names if necessary and click the OK button.



Inserting or Deleting Rows and Columns

Many times you may require adding a row of data or a column of data, which you forgot to enter earlier. Excel provides the facility to insert rows or columns into the existing worksheet.

1. Select the cell(s) where you wish to insert the cell(s), row or column.
2. From the Insert menu.
   i) Choose Entire Column to insert the column.
   ii) Choose Entire Row to insert the row.

Formatting

Excel lets you present numbers in a variety of formats. You can format selected cells using the formatting toolbar from the Format Cells dialog box.

Number Formatting

Excel provides many different number formats like currency, percent and comma style for use with different kinds of data.

Alignment

Excel identifies any data item as a number, date, time, formula and text. By default, Excel applies the appropriate horizontal alignment to each of these. Numbers are right aligned and text is left aligned.

Horizontal Alignment

For horizontal alignment, use formatting toolbar.

Merge and Center centers the contents of a cell across a number of columns. Enter the text in one of the cells; then select the horizontal range of cells across which you want to center the text and click the Merge and Center button.

Setting Horizontal and Vertical Alignments

1. Choose Format -> Cells to display the Format Cells dialog box.
2. Click the Alignment tab to bring it to the front of the dialog box. (See fig)
3. In the Horizontal group box, choose the horizontal alignment option you want.

Excel's default option is left aligned for the text and right aligned for numbers.

Justify aligns selected text to both the left or right margins.

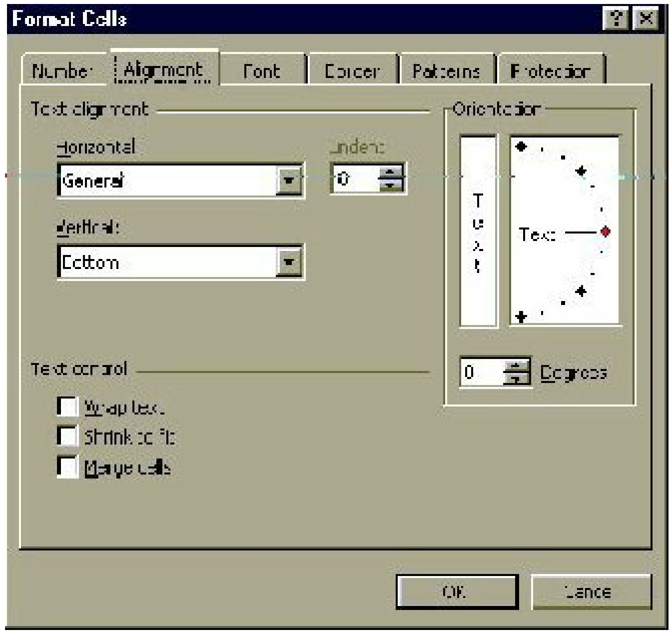
Center across the selection centers the text across the selected columns.

In the vertical group box, specify the vertical alignment for the selected cells by choosing Top, Center, or Justify.

Font Formatting

Excel supports a wide range of font formatting that can be used in the worksheet.

Choose Format -> Cells to display the Format Cells dialog box, click on the Font tab and make your choice on it and then click OK button.

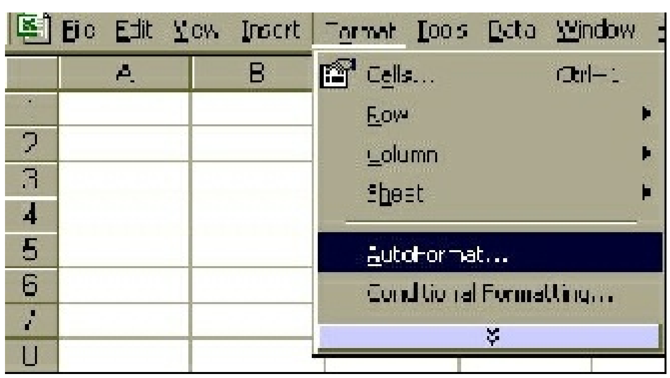


Auto Formatting Worksheets

1. Choose format-> Auto format to display the Auto Format dialog box (see Figure).

2. Choose a format from the Table Format list box and click OK.

3. If you want to apply only some of the formatting characteristics, click the option button to display the six options in the formats to apply group box at the bottom of the AutoFormat dialog box. Clear the check box for the options you do not want to apply.



Formatting Rows and Columns

Row Height

To change the row height for one row quickly, click on the bottom border of a row heading and drag it up or down until the row is of the height you want.

To change row height for several rows at once

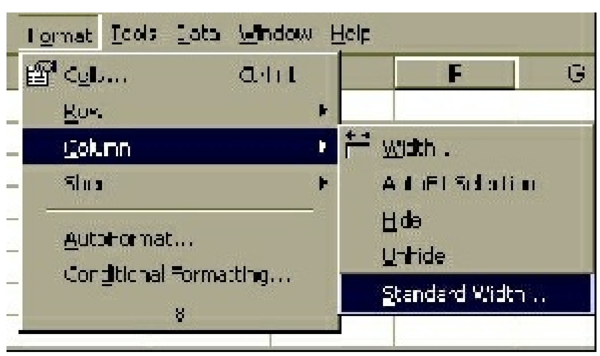
1. Select the rows by dragging the row headings or through cells in the rows.
2. Choose Format -> Row -> Height to display the Row Height dialog box.
3. Enter the new height in points for the rows in the row height text box.
4. Click the OK button to close the Row Height dialog box.

Changing the Column Width

To change column width for one column quickly click on the right hand border of the column height and drag it left or right until the column is of the width that you want.

To change column width for several columns at once:

1. Select the columns by dragging through the column headings or through the cells in the columns.
2. Choose Format-> Columns-> Width to display the Columns Width dialog box.
3. Enter the new column width in the Column Width text box.
4. Click the OK button to choose the Column Width dialog box.
5. You can also set a default column width by choosing Formatting -> Column -> - Standard Width and set whatever column width you want.



Auto Fit (column width/row height)

Auto fit feature automatically adjusts column width/row height to fit the widest in any selected column/row. To use Auto fit, select the column/row you want to adjust and choose

Format -> Column -> Auto fit.
Format -> Row -> Auto fit.

Hide/Unhide of Row or Column

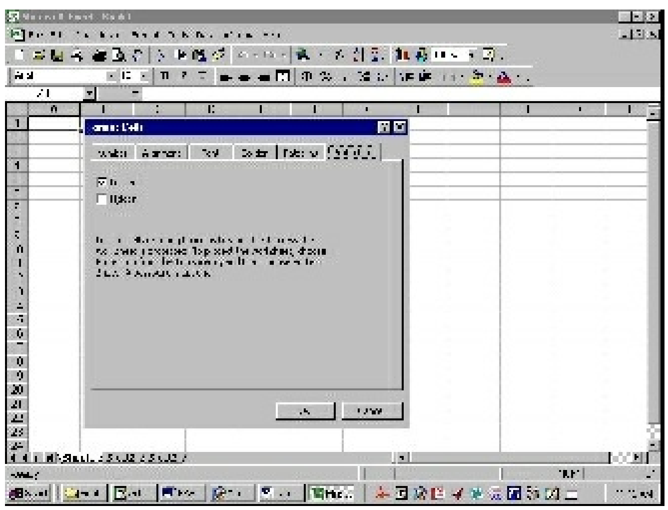
To hide/unhide a column or row; first select the row or column:

Choose Format→ Row/Column →·Hide/Unhide

Protection

Excel's protection is an invisible form of cell formatting. You can format selected cells as either locked or hidden.

1. Choose format cells to display the Format Cells dialog box.
2. Click the Protection tab.
3. Select the Locked or Hidden check box or both.
4. Click OK.



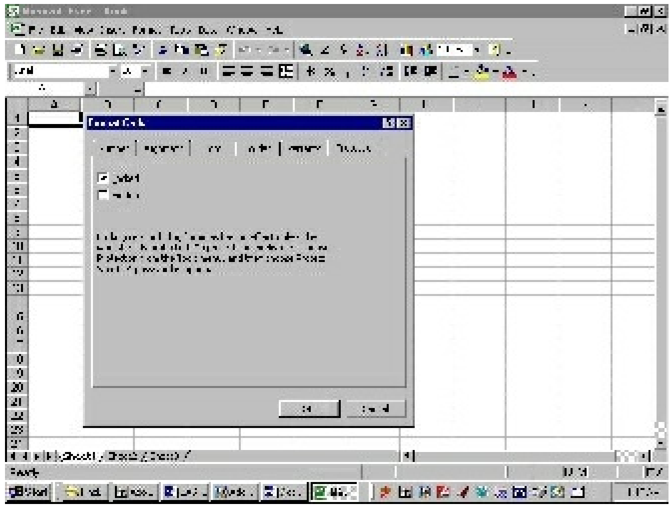
To Protect Worksheet

Choose Tools→Protection→Protect Sheet and choose following options

CONTENTS→Protects the user from changing locked cells or charts.

OBJECTS→Protects the user from changing graphic objects.

SCENARIOS→Protects the user from changing scenarios.

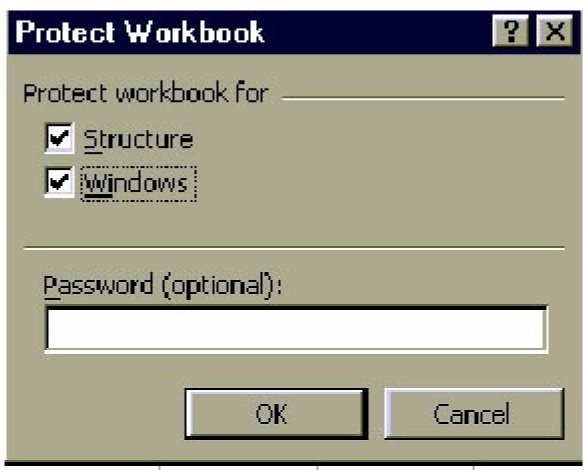


To Protect Workbook

Choose Tools→Protection→Protect Workbook and choose following options

Structure→Prevents the user from moving, deleting, hiding, inserting or renaming worksheets in the workbook.

Windows→Prevents the user from moving, resizing, hiding, or closing the windows in the workbook.



Sorting Data

Excel offers simple sorting for swiftly arranging the contents of a column and complex sorting for arranging the contents of a table using several Sort keys.

Simple Sorting

To sort data in a column or in selected cells quickly, click the Sort Ascending or Sort Descending button on the Standard toolbar. Sort Ascending sorts the cells in the column alphabetically or from lowest to highest value; Sort Descending sorts the cells into reverse alphabetical order or from highest to lowest value. Their first column sorts selected cells.

Complex Sorting

To perform a complex sort on the selected cells:

Choose Data→ Sort to display the sort dialog box

In the Sort dialog box choose up to three sort keys for your data.

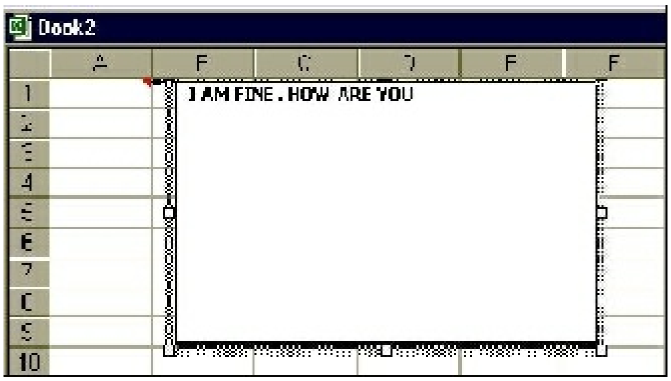
- First, if your data has a header row, make sure the header row option button is selected in My List Has group box. This will prevent Excel from sorting the headers.
- Choose the first Sort key in the Sort by group box and then specify ascending or descending order.
- Choose the second sort key in the first Then by group box. Again specify ascending or descending order.
- Choose the third sort key in the second Then by group box. Again specify ascending or descending order.
- If necessary choose sort options by clicking the options button to display the Sort Options dialog box in which you can choose a special First Key sort order, which will tell you whether to use case sensitive sorting and whether to sort top to bottom or left to right.
- Click the OK button to close the Sort dialog box.

Adding Comments

Excel's comments let you add text notes to any cell. Cell notes do not appear in the worksheet; they are indicated by a small red triangle in the upper right corner of the cell to which they are attached.

To add a note to the active cell:

- Choose Insert→ Comment to display a comment box attached to the cell.
- Type your note into the comment box.
- Click in another cell to continue working.



To edit a comment, right-click in the cell that contains it, and choose Edit Comment to display the comment box with the text ready for editing.

- To resize a comment, move the insertion point over one of its sizing handles and drag inwards or outwards.
- To move a comment so you can see both it and the cells it was covering, move the insertion point into one of its border so that it turns into a four-headed arrow, then click and drag the comment to where you want it to appear.
- To delete a comment, right click in the cell that contains it, and choose Delete Comment from the context menu.

Adding Headers and Footers

To identify the work you print out, you will probably want to add a header or footer.

- Choose View→Header and Footer to display the Header/Footer tab of the Pages Letup dialog box.
- To use one of the automatically generated headers or footers, choose it from the Header drop-down list or Footer drop-down list. Choose (None) at the top of the list to remove the current header or footer.

- To create a custom header or footer, click the Custom Header or Custom Footer button to display the Header dialog box or Footer dialog box, each of which offers Left Section, Centre Section and Right Section boxes.
- To change a section, click in it and edit the contents using regular editing techniques.
- To insert the page number, number of pages, current date or time, workbook name or worksheet name, position the insertion point in one of the section boxes and click the appropriate button to enter the code for the information.

Getting Worksheet Printed

To print your worksheet

- Select the range of the worksheet to be printed.
- You can see the preview of the hard copy you will get.
- Choose File → Print command.
- Select the appropriate options in the dialog box.
- Click OK.

CHARTS

Introduction

Charts are the graphic components of Excel. The data which is entered as tables can be viewed in the graphical form as charts which makes the figures of the data effective, interesting, easy to understand and easy to analyze and compare. Charts can be of two types:

- Embedded charts: These charts are included in the worksheet and can be moved, copied and resized as any other graphical object. Their advantage is that they can be viewed alongwith the data and many charts can be inserted.
- Chart sheet: Separate chart sheets are inserted when a chart is created. It contains only one chart. To create Chart Sheets, choose insert → Chart → As New Sheet.

Two dimensional or three dimensional charts can be created with the help of Excel. After creating a chart, the information can be enhanced by adding chart items such as data labels, text and title. You can do formatting using patterns font, colours, alignment and other formatting attributes. Any change in data will update the changes in the chart which was made using that data.

Chart Components

Two-dimensional charts have an X-axis and Y-axis. Three-dimensional charts also have a z-axis. A typical chart such as one shown below has the following components.

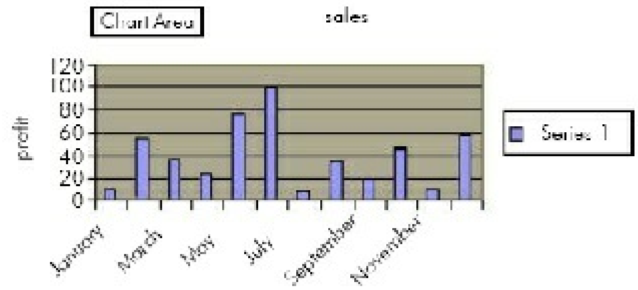


Chart Title – A title given to the whole chart.

X-axis title – A title given to the X-axis range.

Y-axis title – A title given to the Y-axis range.

Legend – It specifies the colour, symbol or pattern used to mark the data series.

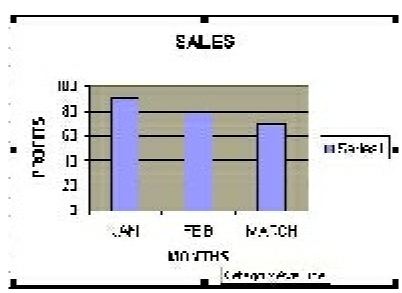
Data Series – A data series is one of the sets of data from which the chart is drawn.

Categories – The items by which the data series is separated. For example ,if a chart shows the years 1992-1999, each year will be a category.

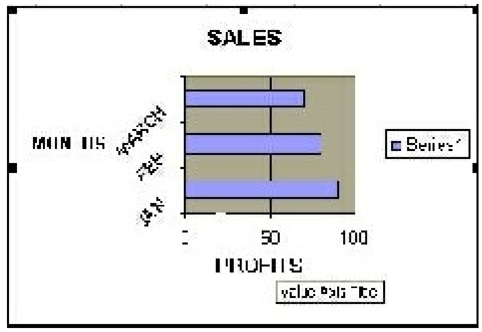
Chart Types

MS Excel offers 15 different chart types. You can choose the chart type to present your data most effectively and clearly. The various chart types are as discussed below:

- Area Chart: This shows the magnitude of change over time. It is a stacked line chart, with the area between lines filled with colour and shading. The data series are plotted one on top of the other. They are good for showing how much the data series contribute to a whole.



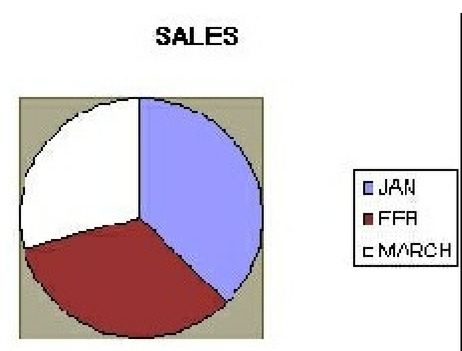
- Bar Chart: It consists of a series of horizontal bars that allow comparison of the relative size of two or more items. A horizontal bar that extends to the left or right of the baseline marks each data point.



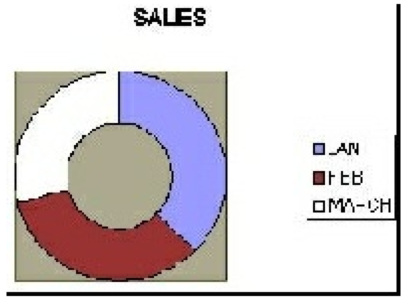
- Column Chart: This consists of a series of vertical columns that allow comparison of the relative size of two or more items. They are typical for showing sales, rainfall etc.

- Line Chart: Each of the data series are plotted as lines of different colour and shading. The chart shows changes in data series over time like changes in prices.

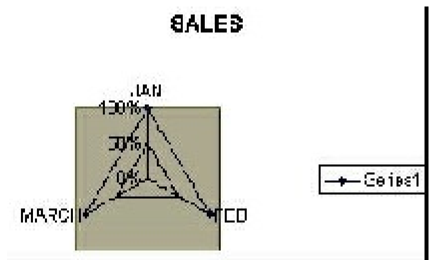
- Pie Chart: A single data series is divided up into pie-slices showing the relative contribution of the various data points. Market surveys are reflected well in pie charts.



- Doughnut Chart: It is similar to pie chart but it represents more than one data series.



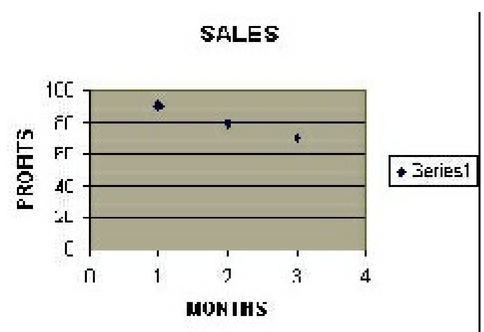
- Radar Chart: This shows the data values in relation to the center point and to each other. Data of the same data series are connected by lines.



- XY (Scatter) Chart: An xy scatter chart either shows the relationships among the numeric values in several data series or plots two groups of no.'s as one series of xy coordinates. This chart shows uneven interests or clusters of data and is commonly used for scientific data.

When you arrange your data, place x values in one row or column and then enter the corresponding y values in adjacent rows and columns.

Diagram



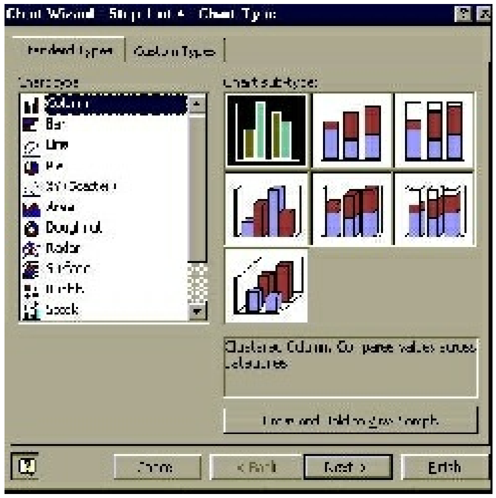
Creating a Chart

The easiest way to create a chart is to use Chart Wizard.

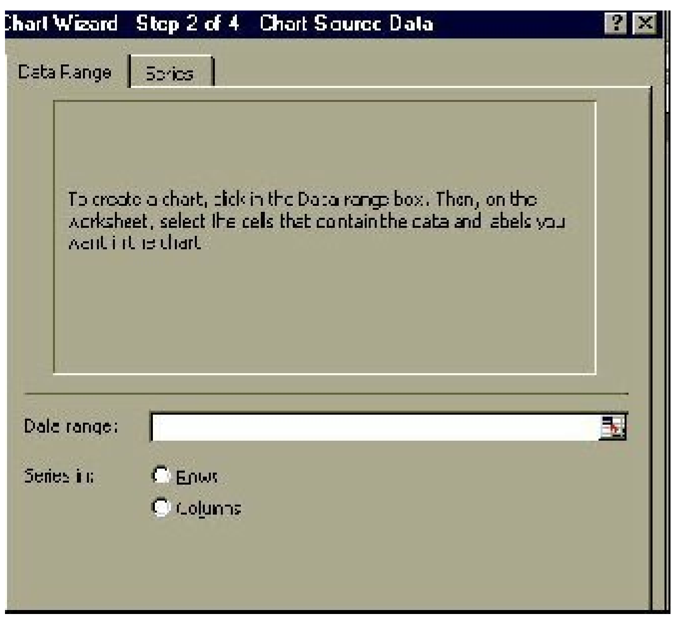
The chart Wizard is a series of dialog boxes that guide the user through the steps required to create a new embedded chart or modify settings for an existing embedded chart. It displays either five steps or two steps, depending on what is selected .If worksheet data is selected, all five steps are displayed because you're creating a new chart. If you have selected an existing chart to modify it, only two steps are displayed. To finish the Chart Wizard choose the finish button in any of the steps.

Following are the steps to create the chart through Chart wizard:

- To create a new chart, enter the data.
- Click on Chart Wizard tool button from standard toolbar or choose Insert→Chart to start the chart wizard.



- Choose the chart type in the chart type list box. Excel will display a variety of available subtypes. Choose a sub type by clicking on it.
- Excel will show a sample chart from the data you selected if you click on the 'Press and Hold to View Sample' button.
- Click the Next button to display the second chart wizard – the Chart Source Data.



- On the Data Range tab, check / enter the data range.
- On the Series tab, adjust the data series as necessary.

- Click the Next button to display the third chart wizard – the Chart Options and select the options as per type of chart.
- On the Titles tab enter chart, X-axis, Y-axis title.
- On the Axes tab, suppress the display of data on any axes if necessary.
- On the Gridlines tab, choose which gridlines to display.
- On the Legend tab, choose a legend and place it as per your choice.
- On the Data Labels tab, choose whether to show the data or not.
- On the Data Tables tab, you can choose to show the data table alongwith the chart or not.
- Click the Next button to display the forth chart wizard – the Chart Location.
- Choose whether to display the chart (1) as new sheet or (2) as an embedded sheet.
- Click the finish button to have the Chart Wizard create the chart for you.

Editing Charts

Once you have created a chart, you may want to update it by adding or deleting more data series or data points from the worksheet, change the chart type, format a chart or draw inside a chart.

Adding or Deleting Data

Adding or deleting data automatically updates any existing legend. Using the chart Wizard, you can change the range that a chart is based on. If your chart was created from multi-level categories and series, you must use the Chart Wizard to reselect your data and recreate the chart.

- To add data to an embedded chart on a worksheet, you can drag and drop data from that worksheet. Using copy and paste is the easiest way to add data to a chart sheet. Or you can use the New Data command for either embedded charts or chart sheets.
- You can also delete data series from a chart by double clicking on that and pressing the Delete key.

Change the Chart Type

Excel lets you easily change a chart from one type to another till you really find a chart which suits your data. This can be done if you follow the given steps:

- Select the chart by double clicking on it. It puts a border around the chart.

- Choose Format à Chart Type and select the new chart.

Or

Click on Chart Wizard tool button (this will show only 2 steps out of 5)

You can also change a chart quickly from one type to another by selecting the chart clicking the chart type drop down button on the chart toolbar and selecting the type of chart you want from the drop down list.

Deleting a Chart

To delete an embedded chart, either click on it and press Delete or right click in any open space inside it and choose cut from the context menu.

To delete a chart sheet, right click the sheet tab and choose delete from the context menu.

Editing an Element in a Chart

To edit an element in a chart, click the element so that it displays handles and its name appears at the left end of the formula bar or on the Chart Objects box on Chart toolbar. Right click the element you want to edit and edit using normal editing techniques.

Removing an Element from a Chart

To remove an element from a chart, right click the element you want to delete and choose clear from the context menu.

Formatting a Chart

Once you create a chart and add chart items such as data labels or titles, you can then format many of the items in the chart.

- Chart area should be selected.
- Press right mouse button to get the short-cut menu and choose Format Chart Area.
- Dialog box opens up where you can globally apply colours, patterns, borders, and text fonts.

One-chart item at a time can be selected and formatted.

There is an easy alternative to selecting and formatting individual chart items, i.e. you can use a built in chart auto format. Or you can create your own auto formats which you can apply to charts. Auto formats work much like templates or styles. Each auto format is based on a chart type. When you apply an auto format to an active chart, it changes the entire look of the chart but does not affect your data.

How to Use a Built in Format

- Select the chart.
- Choose Format -> Auto format.
- Select Built –in, choose any of the charts from the galleries.

How to Create a Custom Format

- Create a chart having Chart type, font, pattern and other formats.
- Activate the chart.
- Choose Format -> Auto format.
- Select the user defined option and click on Customized button.
- Click on the Add button.
- Enter the name for the format.
- Click on OK.

How to Draw in the Chart

- Select the chart.
- Activate the drawing tool bar.
- Click on the appropriate tool button of the toolbar.
- Draw on the chart.

How to Print Charts

- Embedded charts can be printed either with the data by selecting the range of worksheet including the data and the chart or without data also by:
  - Select the chart
  - Choose File -> Print.
- To print the chart sheet
  - Choose file -> page setup.
  - After selecting the appropriate options for the chart size, page size, margins, header, and footer, click on print.

FORMULAS AND FUNCTIONS

Formulas and Functions are extremely easy to use. Formula is a recipe for performing calculations on numerical data. It can be anything from simple addition to complex additions. Function is a predefined formula built into Excel. Excel ships with enough functions to satisfy most computing needs-from Sum to DSTDEVP for calculating standard deviation based on all the entries in a database. You can also create your own powerful formulas as per your requirement.

Parts of a Formula

To create a formula in Excel, you need to indicate the data to be used in the computation and the operation or operations to be performed. Data can consist of constants (numbers) and references to cells. Operations use four categories of operators: arithmetic, logical, text and reference. A formula always starts with an (=) sign.

Constants

A constant is a number entered directly in the formula. It uses a constant value in every calculation, e.g. you could enter the following formula in a cell to add 5 in 13

=13+5.

When you press enter the cell will display 18. The initial "=" sign tells excel that you are entering a formula in the cell, 13 and 5 are constants and the '+' sign is the operator for addition.

References

Reference indicates to Excel the location of the information you want to use in the formula. By using references instead of constants you could build formulas that you don't need to change when the data in your worksheet changes, e.g. to perform the calculation 13+5 you could enter 13 in cell A1 and 5 in cell A2 and then enter this formula in A3

= A1+A2.

This tells excel to add the contents of cell A1 and A2 and show the result in cell A3.

One of the easiest ways to enter references to the formula is to use range names.

Operators

The Operator is the way in which you tell Excel which operation to perform with the data you have supplied by using constants and references. Excel uses four types of operators: arithmetic, logical, text, and references.

Arithmetic Operators

Excel's six arithmetic operators are:

OPERATOR	ACTION	EXAMPLE
+	Addition	=A1+A2
/	Division	=20/D7

^	Exponential	=2^5
*	Multiplication	=D5*2
%	Percent	=90%
-	Subtraction	=B4-B5

Logical Operators

Logical operators are also known as comparison operators

OPERATOR	MEANING	EXAMPLE
=	Equal to	=AI=5
>	Greater than	=D7>9
<	Less than	=6 <5
>=	Greater than equal to	=A3>=250
<=	Less than equal to	=A5<=1000
<>	Not equal to	=A5<>100

True is represented as mathematical 1 and false as mathematical 0. This means that while the cell will display true or false and you are using the result in a formula, it will be treated as 1 or 0 respectively.

Text Operator

Excel uses one text operator the ampersand (&) for joining two levels together for e.g. if cell A1 contains the label 2000 and cell B2 contains the label profit you could use the formula = A1 & B2 to produce the result 2000 profit in another cell.

Reference Operators

Excel uses three reference operators for defining references.

Operator	Meaning	Example
Range	Refers to the cells between (and including) the two reference cells	A1:A3
Union	For combining two or more references into one	Sum (A1:A3, A5:A7)
(Space) Intersection	Indicates a reference to a cell or cells shared by two references	Sum (A3:B10 A4 : D4)

The range operator and the union operator are straight forward whereas the intersection operator needs a word or two of explanation .The intersection operator refers to the cells shared by two references – in this example cells A4 and B4 because both are in the range A3: B10 and the range A4:D4.

How Excel uses Operator

Excel evaluates the operators in order of precedence as shown below.

OPERATORS	ACTION
-	Negation (negative numbers)
%	Percent
^	Exponentiation
* And /	Multiplication and division
+ And -	Addition and subtraction
=, >, <, >=, <>, <=	Comparison

When two operators have the same precedence, Excel evaluates them from left to right.

Use parenthesis to change the order in which excel evaluates the operators in a formula. Excel evaluates the contents of the parenthesis first.

For example if you wish to calculate 50*100-40 the result will be 4960 whereas if you wish to calculate 50*(100-4) then the result will be 3000.

You can create a formula by typing it straight into the cell or reference area of the formula bar and then click the enter button.

Copying and Moving Formulas

Formulas can be copied about a workbook by using regular cut, copy, paste commands. But with formulas that contain cell reference, you need to consider the effect that copying or moving the formula will have on the references.

Absolute, Relative and Mixed References

By default, Excel uses relative references that work relative to the cell containing the formula. For example, suppose you have two column of numbers, A and B, and you want to subtract the value in each B cell from the value in the corresponding A cell. You could enter in cell C1 the formula =A1-B1, copy it and paste it in the remaining cells in column C. With relative references, Excel will adjust the formula it enters in each cell so that each performs the same relative operation. Relative references are useful in creating worksheets quickly.

An absolute reference refers to the same cell in a worksheet no matter where you copy or paste it to. For example suppose you want to add sales tax to the previous example and the cell D10 held the current tax rate. If you use the relative reference for D10 in the first formula (=(A1-B1)*D10) and paste it to other cells in column D, Excel would change D10 to D11, D12 and so on and calculate the result accordingly. But when you use an absolute reference, Excel will not change the reference and will only use D10 as the reference.

Excel uses the dollar sign ($) to denote absolute references so the absolute reference for the cell D10 would be D10.

Mixed references are references in which either the column fixed and the row relative ($D10), or with the column relative and the row fixed (D$10).

Functions

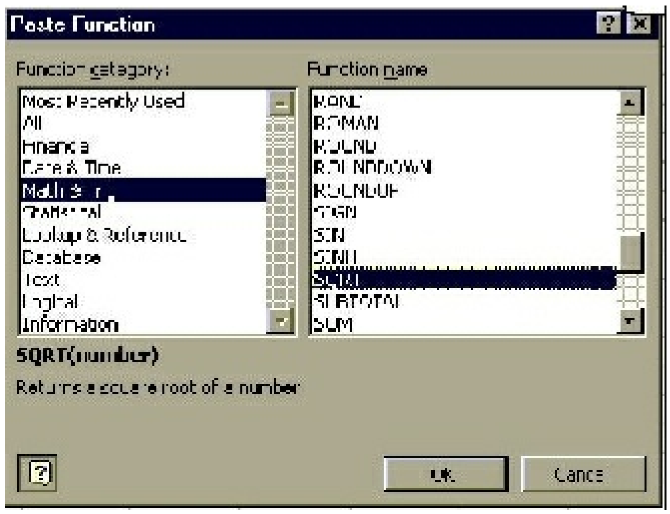
A function is one of Excel's built-in formulas. For example, the SUM formula adds the contents of the specified range. You can enter functions in your worksheets by simply typing them in. The functions perform the operation on the given
values and return the result that is displayed in the same cell where function was entered.

Some important functions are discussed below.

SQRT()

The SQRT function calculates the squareroot of any number. Let us take an example in which we want to find out the square root of the number 9. This can be done in the following way:

- Choose Function from the Insert menu.
- Choose Maths and Trigonometric from the Function category and SQRT from the function name.
- Either type the cell address or point to the cell which contains the number for which square root has to be calculated.
- The result would be displayed in the cell where you had initially placed the cursor.

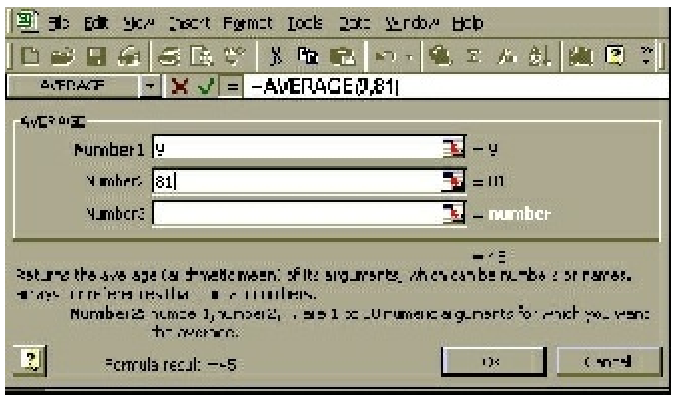


AVERAGE()

The AVERAGE() function calculates the average of the series of specified number. In our present example, we have two numbers 9 and 81 for which we want to calculate the average .

- Place the cursor where you want the function result to appear and choose the function from the insert menu.
- Choose Statistical from the function category and Average from the function name.
- Either type the range or point to the cells which contain the numbers for which average has to be calculated.

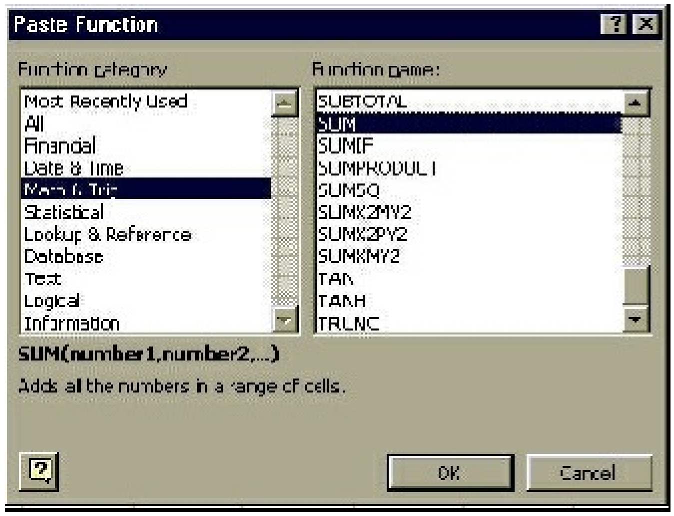
The result would be displayed in the cell where you had initially placed the cursor.



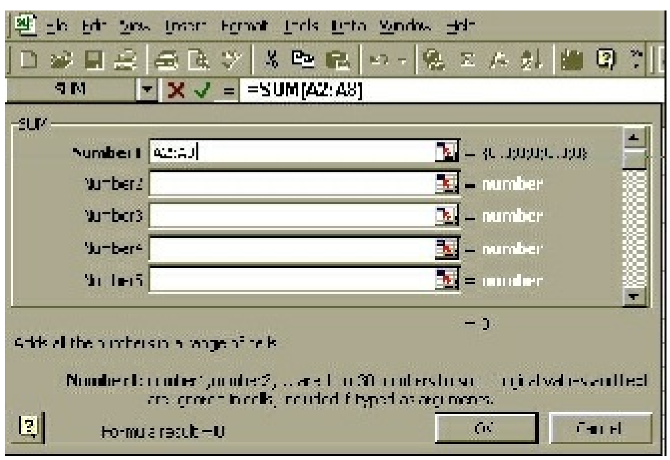
SUM()

The SUM() function calculates the sum of entries in a specified range . Let us see how this can be done:

- Place the cursor where you want the function result to appear and choose function from the insert menu.



- Choose Maths and Trig from the function category and SUM from the function name.
- Either type the range or point to the cells which contains the numbers which you want to add up, you may even specify to discontinuous ranges using the second field.
- The result would be displayed in the cell where you had initially placed the cursor.

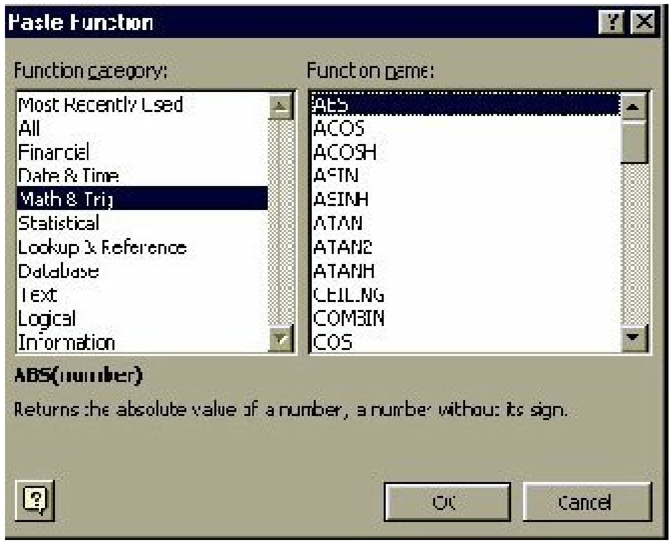


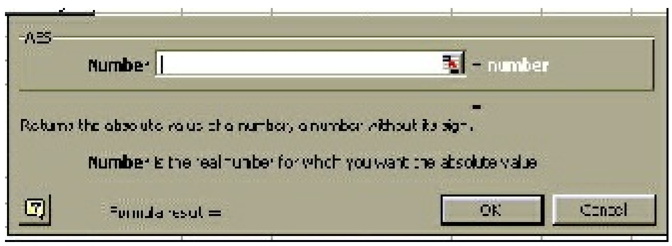
ABS()

The ABS() function is used to get the absolute value of the number. The absolute value of a number means the number without plus and minus sign. In our present example we have a number –45 in the cell A11 for which we want to get the absolute value. Let us see how this can be done.

- Place the cursor where you want the function result to appear and choose function from the Insert menu.
- Choose Maths & Trig from the Function category and ABS from the Function name.

- Click once on the OK button.

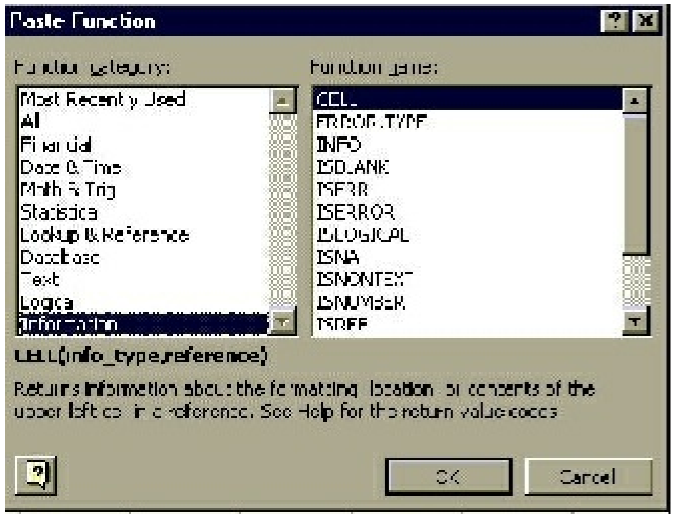


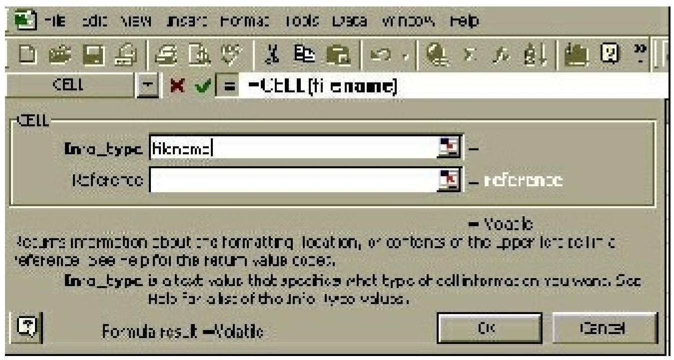


CELL ()

The CELL() function returns information about the formatting , location ,or contents of the upper left cell in a reference .This is a fairly useful command and it gives you all kinds of information about a cell or about the current file .

- Place the cursor where you want the function result to appear and choose Function from the Insert menu.
- Choose Information from the Function category and CELL from the Function name.
- Type ‘Filename’ in the info_type field.
- The result would be displayed in the cell where you had initially placed the cursor.

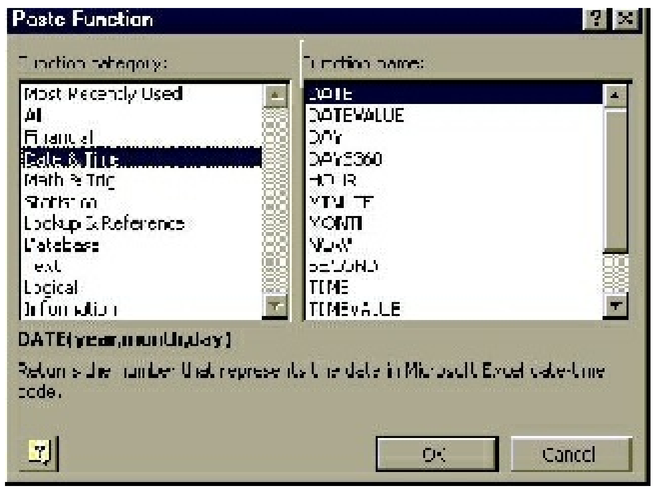

Paste Function
Most Recently Used
All
Financial
Date & Time
Math & Trig
Statistical
Lookup & Reference
Database
Text
Logical
Information
CELL
ERROR.TYPE
INFO
ISBLANK
ISERR
ISERROR
ISLOGICAL
ISNA
ISNONTEXT
ISNUMBER
ISREF
CELL(info_type,reference)
Returns information about the formatting, location, or contents of the upper left cell in a reference. See Help for the return value codes.
OK
Cancel

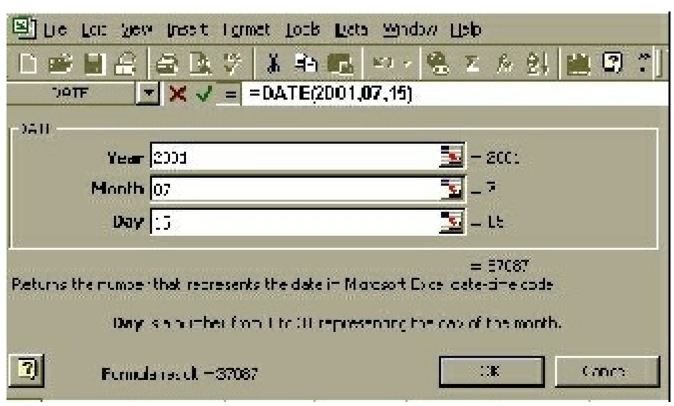

File Edit View Insert Format Tools Data Window Help
CELL
=CELL(filename)
CELL
Info_type
filename
Reference
= reference
= Volatile
Returns information about the formatting, location, or contents of the upper left cell in a reference. See Help for the return value codes.
Info_type is a text value that specifies what type of cell information you want. See Help for a list of the info_type values.
Formula result =Volatile
OK
Cancel

TODAY()

The TODAY() function is one of the few functions that do not require any user argument. It simply returns the current date. Let us see how this works.

- Place the cursor where you want the function result to appear and choose Function from the Insert menu.
- Choose Date & Time from the Function category and Today from the Function name.
- The result would be displayed in the cell where you had initially placed the cursor.





Automating Worksheet

MS Excel provides tools to automate our regular tasks. These tools are Macros and Templates. Excel supports VBA (Visual Basic Application) which is a language based on Visual Basic Programming language.

Programmers can create custom applications using VBA or non-programmers can automate their routine work by creating macros.

Templates are reusable models that standardize the look of the worksheet. They can be used to create periodic reports.

What are Macros?

Macros are actions created through the macro recorder by observing actions, converting those actions into visual basic code and sorting the code in a visual basic module. These recorded actions can be performed again more easily and quickly by simply clicking a button or a key combination.

How to Record a Macro

- Choose Tools-> Record Macro -> Record New Macro command.
- Type the name in the Macro name box.
- Type the description of the macro in the Description box.
- Choose the Options button to set options for the macro.
- Choose the OK button.
- Type the name of the months in cell range A1:A12 and make the entries bold.
- Click the Stop Macro button.

  Or

  Choose Tools-> Record Macro -> Stop Recording command.

How to Run the Macro

Running the Macro means to repeat the action recorded as a macro. To run the Months Name Macro follow the given steps.

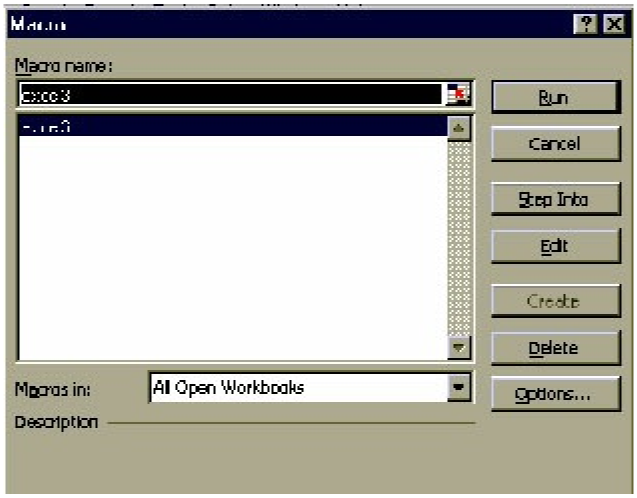
1. Choose Tools->Macro command
2. In the Macro name/Reference box, type or select the macro name.
3. Click on the Run button.

Or

Choose Tools-> Months

Or

Press Ctrl+Shift+M key combination.



How to Delete a Macro

As the macro has been recorded in a separate sheet, deleting that sheet will delete the macro. Macro can also be deleted from the Tool menu. The necessary steps to carry out the above mentioned ways for deleting the macro are given below.

- Select the macro sheet or sheets, which you want to delete.
- Choose Edit-> Delete Sheet command.

Or

- Choose Tools-> Macro command
- Select/type the Macro name
- Click on the Delete button

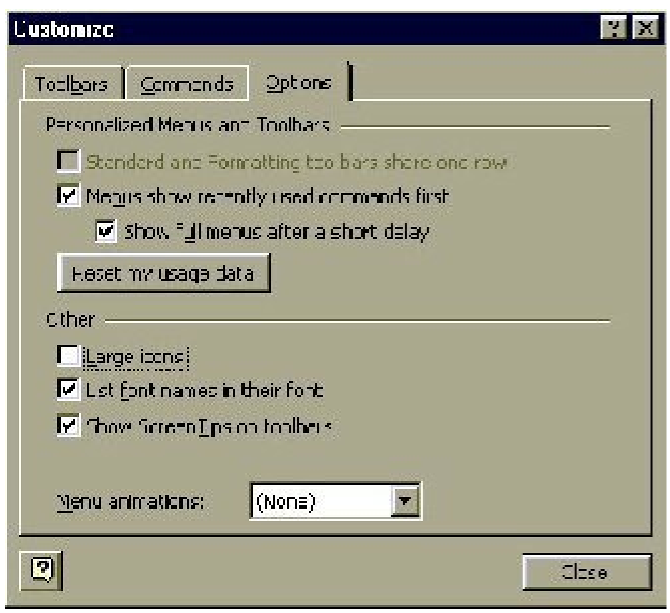
Macro
Run
Cancel
Step Into
Edit
Create
Delete
Options...
Macros in
All Open Workbooks
Description

How to Assign the Macro to Toolbar, Menu or Shortcut Key

Once you record a macro, you can attach it to a menu item, button, or a shortcut key, making it as accessible and convenient as the built-in menu commands and buttons in MS Excel. A macro assigned to Tools menu or shortcut keys is always available and a macro assigned to a toolbar button is available when the toolbar is displayed. If you assign your macro to a build-in button that MS Excel already uses, you override the button's normal function with that of your macro.

To assign the macro to the tool button, follow the given steps:

- Choose View-> Toolbars command.
- Click on the Customize button.
- Select Custom from the list of categories.
- Drag the last tool button of the 3rd row and place it on the toolbar. This will open up the Assign Macro dialog box.
- In the Macro name/Reference box, select/type the name of the macro and click on OK button.
- Choose the Close button to close the Customize dialog box.



How to Restore the Tool Button

- Choose View->Toolbars command.
- Click on Customize button.

- Select Custom from the list of categories.
- Drag the tool button from the toolbar back to its place in the Customize dialog box.
- Click on Close button.

What is a Template?

A template is a special workbook which can be used as a pattern to create other workbooks of the same type. In addition to creating new workbooks based on templates, you can insert sheets from templates into your workbooks.

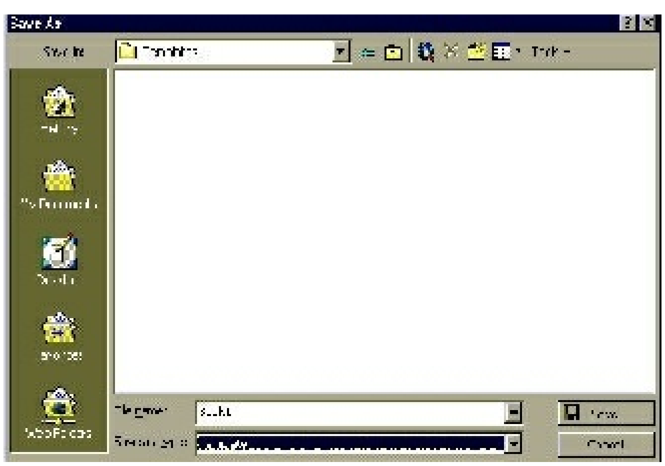
Templates can contain text and graphics, formatting and page layout, formulas and macros.

You can create special templates, called autotemplates, in your Startup or Alternate Startup directory. Auto templates can also be used as the basis for all new workbooks and all new sheets you insert in your workbooks. Auto templates are just templates saved with a specific name on a specific
location.

How to Create a Template

To create a template, follow the given steps:

- Create a workbook with all the styles, formatting, text and formulas you want.
- Choose File-> Save As command.
- In the File Name box, type the name of the template.
- Select the directory and drive where you want to save the template.
- In the Save File As Type box, select Template.
- Click on OK button.



How to Open a Template

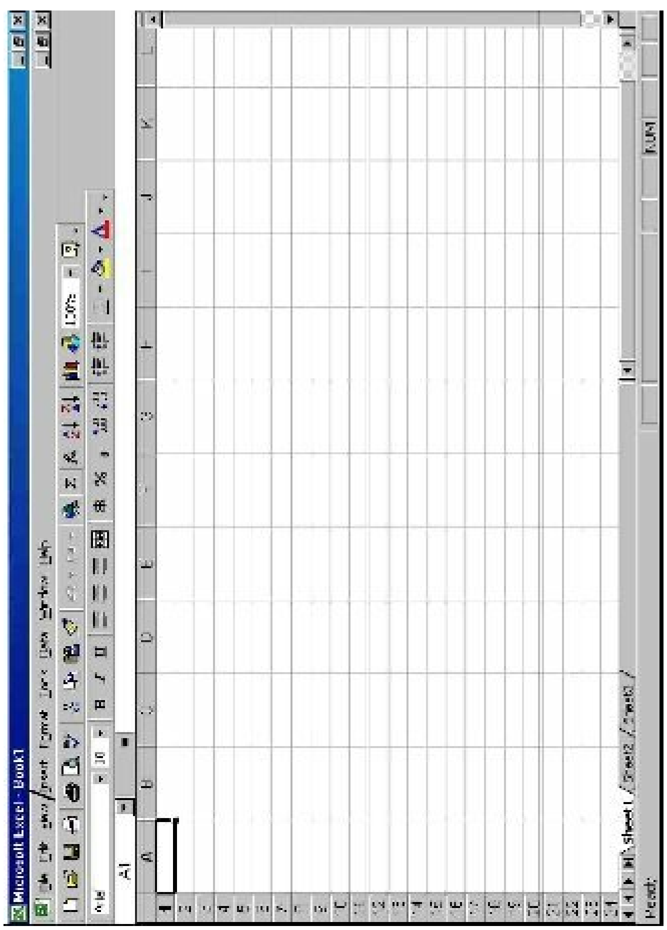
To open a template to create the worksheet based on it, follow the given steps:

- Choose File-> New command.
- Select the template on which you want to base a new workbook.

How to Modify Original Template

To edit the original templates, follow the given steps:

- Click on the Open button on the standard toolbar or press Enter.
- Select the template you want to open.
- Hold down SHIFT key and click on OK button. MS Excel opens the original template for editing.
- Make the needed modifications in it and click on Save button.



POWERPOINT

Introduction

PowerPoint is a presentation tool that helps you create effective, audio-visual-graphical presentations. Generally the presentations consist of a number of slides that are arranged in a sequential manner. One can put the animation effects to give the presentation a different and impressive look. Not only that, PowerPoint can also be used to prepare handouts and speaker notes automatically once the presentation is finally prepared. The slides prepared can be used either by taking out the printouts on the transparency slides or the computer can directly be attached to the LCD display panel that can enlarge the picture and present the output on the screen.

PowerPoint has provided the user with lots of predesigned slide formats, clip art graphic libraries, autocontent wizards and design templates. The user can use any of the available options and design the presentation depending upon the time and the requirement. By using the predefined slide formats, one can prepare the presentation on standard formats and designs whereas by creating one's own slide formats, the user can give new creative looks as per the requirements.

Other office components, like Word file, Excel spreadsheet or graph etc. can also be inserted in the presentation to make it more complete and attractive.

We shall first have a look at all the menu items and then start working on a presentation as an example.

Menus

File Menu

1. New: Creates a blank new file based on all default values.
2. Open: Opens an existing file.

3. Close: Closes the existing file (without exiting from the application).

4. Save: Saves the active file with the current file name, location and file format.

5. Save As: Saves the active file in a different file name, location and the file format.

6. Save as Web Page: Saves the file in the format required for the Internet applications.

7. Pack and Go: Starts the Pack and Go wizard. This helps you pack up a presentation so that it can be run on another computer. This wizard can be run again if some updation is required in the presentation.

8. Web Page Review: This allows you to preview the current file as a web page in your browser so that you can see how it actually looks like.

9. Page Setup: Sets the margins, paper source, paper size, page orientation and other layout options for active files.

10. Print: Prints the active file or the selected part to the selected printer.

11. Send To: Sends the document to the briefcase or the mail recipient as an e-mail.

12. Properties: Displays the property sheet for the active file.

13. Exit: Closes the application program after prompting you to save all the unsaved files.

Edit Menu

1. Undo Last command(s) reverses the last command i.e. undoes the effect of the last command you executed.

2. Repeat Last Command(s) reverses the undo command i.e. restores the last

command.

3. Cut: Removes the selection from the active document and places it on the clipboard – a special place in computer's memory from where it can be retrieved again.

4. Copy: Copies the selection to the clipboard.

5. Paste: inserts the content of the clipboard at the insertion point and replaces any current selection block.

6. Paste Special: Pastes, links, or embeds the clipboard content in the current file in the format you specify.

7. Paste as Hyperlink: Inserts the content of the clipboard as a hyperlink at the insertion point, replacing any selection.

8. Clear: Deletes the selected object or text without putting it on the clipboard.

9. Select All: Selects all text and graphics in the active window, or selects all the text in the selected object.

10. Duplicate: Makes a quick copy of a selected object. To make additional copies of the same object, click duplicate again.

11. Delete Slide: Deletes the current slide in slide or notes view. Deletes the selected slides in slide sorter or normal view.

12. Find: Searches for specified text, formatting, symbols, comments, footnotes or endnotes in the active document.

13. Replace: Searches for and replaces specified text, formatting, footnotes, endnotes or comment mark in the active document.

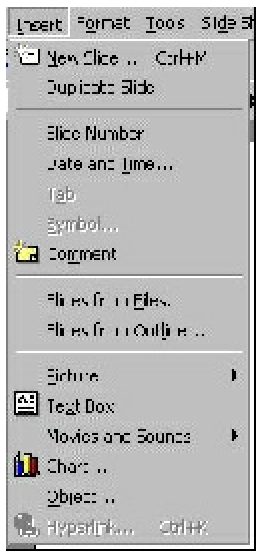
14. Go to Property: Moves the insertion pointer to the item where you want to go.

15. Links: Displays or changes information for each link in the current file, including the name and location of the source file, the item, the type and whether the link updates automatically or manually.

16. Text Object: Activates the application in which the selected object was created so you can edit the object in place.

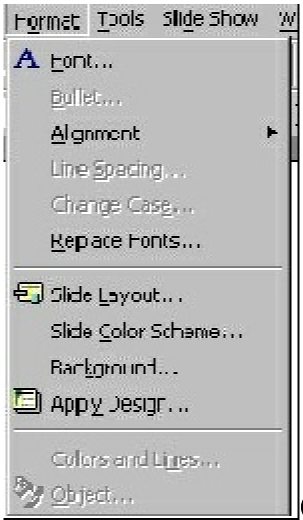
View Menu

Insert Menu

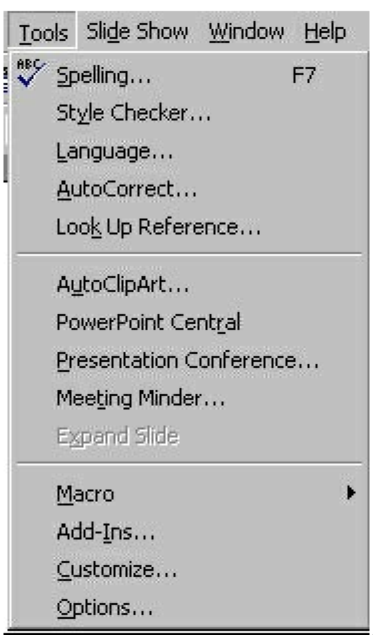


Format Menu

- Font: Modifies the font type, colour, format, character spacing etc. of the selected text
- Bullets and Numbering: Adds/removes the bullets/numbers from the selected text.
- Alignment: Aligns the selected text to the left, right, center or justifies.
- Line Spacing: Sets the space between the lines.

- 

Change Case: Changes the text to lower case, uppercase, sentence case, toggle case or title case.
- Replace Fonts: Replaces the existing font type with the another.
- Slide Layout: Changes the layout of the slides.
- Slide Colour Scheme: Modifies the existing colour scheme.
- Background: Modifies the background of the slide.
- Apply Design: Applies the design template to the presentation.
- Colours and Lines: Applies the different styles and colours to the lines and outlines.
- Autoshapes: Helps you change the colour, shape, fill, size and position of the objects.



Tools Menu

- Spelling: Checks the active document for possible spelling, grammar and writing style errors.

- Language: Designates the language of the selected text in a file.
- AutoCorrect: Sets the options to correct the text automatically as you type.
- Look Up Reference: Inserts the cross references.
- Meeting Minder: Here meeting minutes can be made and actions can be recorded at that time of presentation.
- Macro: Here you can add, run, edit or delete a macro.
- Add-Ins: Attaches a different template to the present slide.
- Customize: Helps in customizing the toolbar buttons, menu commands etc.
- Options: Modifies the settings for the MS Office programs.

Slide Show

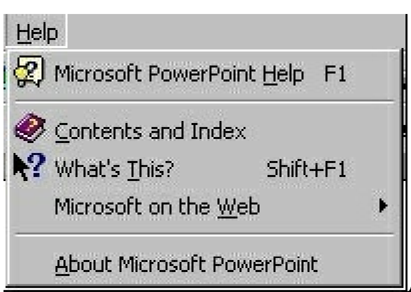
- View Show: Runs the slide show of the presentation.
- Rehearse Timings: Runs the slide show in the rehearsal mode. Here the timings can be set or modified.
- Record Narration: Voice can be added here.
- Set Up Show: Options are set here, in terms of type of presentation, transition and animation settings, sound effects and slide proceeding.
- Action Buttons: Buttons are added for the action settings.
- Action Settings: Assign actions to the action buttons.

- Preset Animation: Different animation actions can be applied in the slides.

- Custom Animation: Animation effects like sound, text, movements etc can be applied or modified by this option.
- Animation Preview: Runs all the animation effects in the current slide.
- Slide Transition: Adds or modifies the transition settings between the slides.
- Hide Slide: Hides the current or selected slide(s).
- Custom Shows: Sets the shows within the show.

Window Menu

- New Window: Opens a new window with the same contents as the active window which helps in viewing different parts of the same file at the same time.
- Arrange All: Fits all the open files at the same time that makes formatting options easier among various presentations.
- Fit to Page: Puts active presentation on the top of all the open presentations (opened) in different windows.
- Cascade: Arranges all the open presentations overlapping each other.
- Next Pane: Moves clockwise to the next pane in the presentation.
- Presentation: Lists the current open presentation .



Help Menu

- Microsoft PowerPoint Help: Launches the MS Office Assistant that provides the help and tips to work with MS PowerPoint.
- Show the Office Assistant: Displays/removes the Office Assistant from the view.

- What's This? Displays the particular topic on which help is required.
- Office on the Web: Connects you to the MS Office web site from where the updated information can be downloaded.
- Detect and Repair: Finds and fixes the errors automatically.
- About Microsoft PowerPoint: Displays the PowerPoint's version details, copyright message and system information.

Auto Content Wizard

Generally preparing presentations is difficult because a lot of designing, inserting text boxes, clip arts, graphs etc are required. But just imagine that everything is prepared and now you just have to change the contents of the presentation. PowerPoint makes your job easy as it has all the things prepared and it keeps asking you questions about the slides you want to prepare and prepares the slides automatically. How does that sound? Easy? So let us try to prepare the presentation this way!

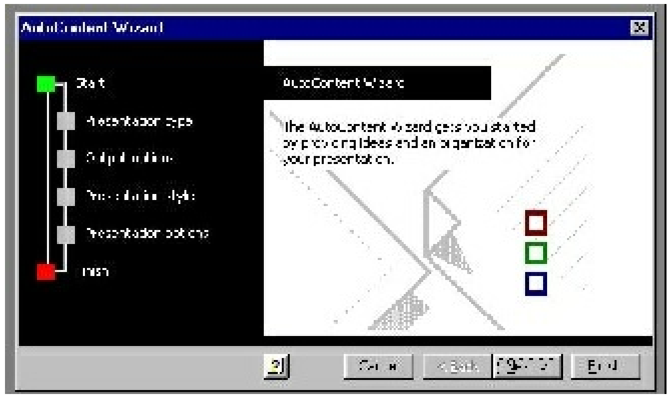
Let us proceed step by step:

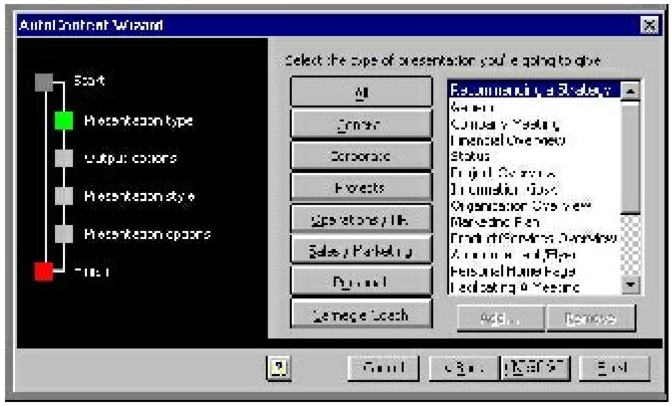
- Click on start button.
- Click on Microsoft PowerPoint from the programs menu.
- Click on AutoContent wizard button.
- Click on OK to continue.
- Click on next tab to select the type of presentation.
- Select "Recommending a Strategy" from "general" option as the presentation type.
- Choose "on-screen presentation" button to get the type of output you would like to use.
- Type presentation title here.
- Click on finish button to see the output.

Here, in this example, there are a total of seven slides, each slide containing some sub information or headings. Now you can make changes or overwrite on either one of the parts. This means if you make changes that in the left frame or in the right frame, the other part will automatically be changed.

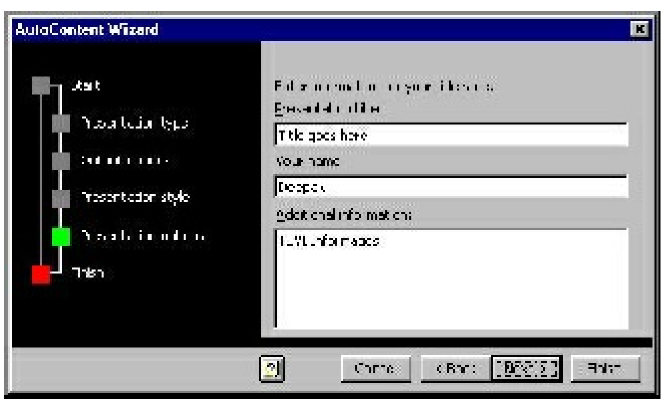
Although these slides are predefined, you can add, delete or modify any of the parts present in the given content as per your requirement. The number of slides can also be increased or decreased as desired. You can change the text, the colour scheme, the clipart images etc on any of the slides.

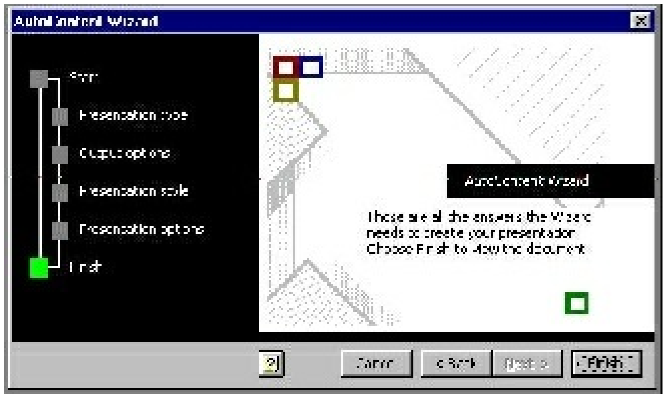
The AutoContent Wizard can help you focus on the key issues about any of the topics (that are already given) without thinking much about them and also saves a lot of your time in designing etc.


AutoContent Wizard
Start
Presentation type
Presentation options
Finish


AutoContent Wizard
Start
Presentation type
Output options
Finish
All
Corporate
Projects
Sales / Marketing
Carnegie Coach
Status
Marketing Plan
Personal Home Page
Remove


AutoContent Wizard
Start
Output options
Presentation style
Internet, kiosk
Cancel
< Back


AutoContent Wizard
Start
Presentation style
Finish
Title goes here



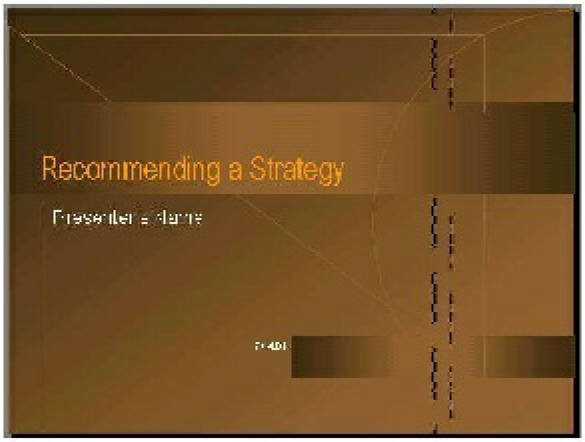
Templates

Similar to AutoContent wizard there is another option available to PowerPoint users which can help you make your presentation in very little time but giving it a professional touch. This sounds surprising but this option is also available in which you can choose your own layouts, backgrounds, images, colour schemes etc from the given library. This option is called Templates.

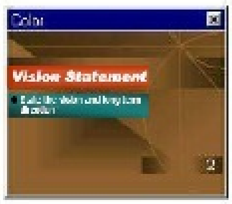
Let us now see how it works

- Click on start button.
- Click on Microsoft PowerPoint from the programs menu.
- Click on Design Template button.
- Click on OK to continue.
- Check the various template designs given one by one – you can see the preview of the selected template in the right part of the window.
- Select "Lock and Key" template and press OK to continue.
- The following window would be displayed.
- You can choose any of the page layouts and press OK to continue.

Now all the steps are same as in AutoContent Wizard for preparing a normal presentation. Here also you can make changes in the colour schemes, the clip art images or backgrounds and layouts etc.

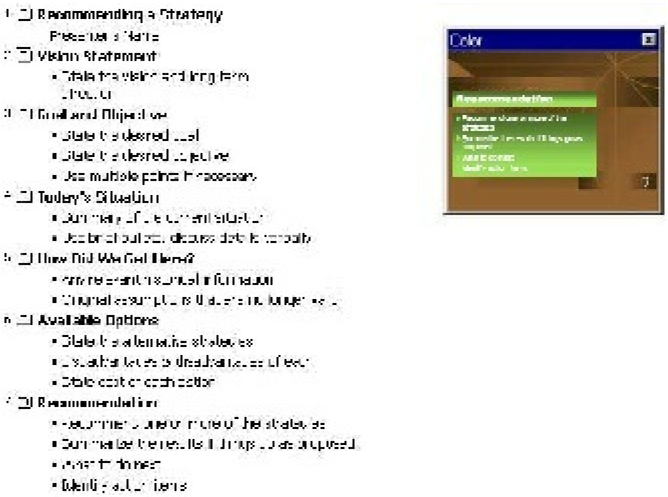


1 Recommending a Strategy
  Presenter's Name
2 Vision Statement
  - State the vision and long term direction
3 Goal and Objective
  - State the desired goal
  - State the desired objective
  - [illegible]
4 Today's Situation
  - Summary of the current situation
  - [illegible]
5 How Did We Get Here?
  - Any relevant historical information
  - Original assumptions that are no longer valid
6 Available Options
  - State the alternative strategies
  - List advantages & disadvantages of each
  - State cost of each option
7 Recommendation
  - Recommend one or more of the strategies
  - Summarize the results if things go as proposed
  - What to do next
  - Identify action items



1 Recommending a Strategy
Presenter's Name
2 Vision Statement
- State the vision and long-term direction
3 Goal and Objective
- State the desired goal
- State the desired objective
- Use multiple points if necessary
4 Today's Situation
- Summary of the current situation
- Use simple bullets, discuss details verbally
5 How Did We Get Here?
- Any relevant historical information
- Original assumptions that are no longer valid
6 Available Options
- State the alternative strategies
- List advantages & disadvantages of each
- State cost of each option
7 Recommendation
- Recommend one or more of the strategies
- Summarize the results if things go as proposed
- What to do next
- Identify action items

1 Recommending a Strategy
Presenter's Name
2 Vision Statement
- State the vision and long-term direction
3 Goal and Objective
- State the desired goal
- State the desired objective
- Use multiple points if necessary
4 Today's Situation
- Summary of the current situation
- Use simple bullets, discuss details verbally
5 How Did We Get Here?
- Any relevant historical information
- Original assumptions that are no longer valid
6 Available Options
- State the alternative strategies
- List advantages & disadvantages of each
- State cost of each option
7 Recommendation
- Recommend one or more of the strategies
- Summarize the results if things go as proposed
- What to do next
- Identify action items



Applying Transitions, and Animation Effects

An electronic presentation, or the slide show, is used to give the presentation on the computer screen or on the LCD projector. Now since these slides are changed by using the computer only and not manually, special effects can be added to the slide show to make it more effective. A transition is a special effect added to the slide show to change it's initial appearance on screen like it can be made to appear from the top, fades in gradually, or the background changes.

Not only this, animation effects can also be added to the slide show for e.g. different points in bulleted form appearing one by one from each of the four directions, or the objects having the animation effects etc.

Adding Transitions

Most of the templates include transition effects in them to make the presentation more effective and lively, but never mind, you can also put these effects in your slides to make them at par with the pre-designed templates. Add the transition in your slide click on the slide show menu and then select slide transition form the menu. You can chose the type of slide transition from the drop-down list.

Most of the listed transitions differ only in directions. Once you apply any of the given transitions, a transition icon appears at the bottom of the slide. On clicking this icon, the transition reappears in the slide miniature. You can see the various types of available transitions and then select the best suited.

Speed and Sound

You can also give special effects like speed and sound to the slide show. Here each type of transition has a default speed but you can change it as you want it to. For that also you have to go to the slide show menu, select the transition type and the same window will appear. You can choose the effect from the drop-down list, select the type of transition and then specify its speed. Now in the advanced section you can enter the timings for automatic slide advances. There is another section in the window that contains the sounds drop-down menu and you can select the type of sound from that menu.

Not only this you can assign the sound loop that will continue till new sound is assigned to it.

Animation

Transition is used between slides whereas animation effects are used within the slide. Various titles, bullets, the objects, graphs or tables can be added in the slide separately using animation effects.

REVISION EXERCISES

1. Prepare a business letter to your customer promising to attend to his complaint immediately. Use page setup, formatting features, etc.
2. Prepare a table in which the budget comparison of three years is made.
3. Write a thank you note to be sent to all your friends who had greeted you on new year.

Chapter 14: DATA BASE MANAGEMENT SYSTEMS

In early day computing, data was kept in data files and programs were written to interact with these data files in order to produce reports. This type of environment lead to a situation in which every new application required the services of an experienced programmer, who usually took a fairly longtime
to study, design, develop and test his application. Very often the number of programmers in an organization were limited and computing requests of various departments were many. This resulted in a long queue of undeveloped applications and a general feeling of dissatisfaction about the wisdom of the investment in computers.

World over the computer professionals were aware of this problem and were busy researching to find ways and means of improving productivity. One obvious point, which came to the forefront was that a major portion of their programming effort involved file handling, in which lines of code for opening, closing, writing, deleting etc had to be written for every program.

Apart from this, if computers were to deliver their full potential, it was essential that the actual user of application should become eager to accept the computer as a friend.

All these factors along with several other considerations led to the development of file management systems, in which most of the common file management programs were incorporated, thereby eliminating the need of writing separate programs for them.

This, translated into action, meant that with the help of easy and simple commands, the user is presented with a screen to create, edit, save a file or enter data into the file. This data in then retrieved for any condition specified through simple commands.

File managers are useful when dealing with single files. However, as it will be discussed later, complex application require the data to be organized in more than one file. As such, in order to cope with this reality, file manager's capability was extended leading to the creation of database management systems.

A database management system can be thought of as a manager of the database consisting of different types of data organized into several files.

The data model used by most available DBMS is one in which information is grouped into files. Each file contains records. Each record contains information about a particular instance of an event or an object, and all the records represent similar events or objects. The terminology used is as follows:

Entity: It is a real world object or event which is of interest to us. For example, if we are interested in computing the Payroll of the company, one of the real word object of interest to us is the employee.

Attributes: These are the characteristics or properties of the entity. For example the characteristics of employee for the payroll application will be staff number, name, designation, basic pay, allowances, number of leaves, advances/loans and so on.

Practically speaking, in the RDBMS approach, each entity represents a table and each attribute comprises a field of the table. All fields combined for one particular instance of the entity is called a record or tuple. All records taken together constitutes the table.

MORE ON FIELDS

Field Names: every field must have a name so that data in the field can be accessed using that name. Usually field names are chosen represent as closely as possible that real word items they represent. Each DBMS has its rules for naming conventions to be used.

Field Types: Data types: since the user may want to treat data in different ways, DBMS allows the user to define the data types as numeric, character, date, logical, memo, etc. A user has to be very careful in selecting the data type. For example a staff number of 001234 , at first instance tempts the user to jump to the conclusion that the data type should be numeric. However when you print this out, the staff number is printed as 1234. As a general rule always define character data type for any number on which no calculation has to be done now or in the future.

DATABASE FEATURES

Covered below are some of the features which differentiate database management from ordinary data processing.

Operation Modes

The interaction of the user with the database can occur through command driven mode, menu-driven mode and program driven mode. Some database systems have all the three capabilities while the others are built around only one.

The Command Mode

Here the user gives commands to the DBMS interactively. Due to this feature some technical experience is necessary and is therefore not popular with people who wish to use the database once in a while.

Menu Driven Mode

This mode of operation is generally used by user with small and clearly defined applications. The advantage of this method of operation is that it gives all necessary choices on the screen and as such the user need not have much technical expertise.

Program Mode

In case the users needs are very complex, then manipulation of the database has to be done through one or many application programs. In such a situation where a large amount of data processing is involved program mode is best suited.

Data Access

Database systems demands that data should be accessed easily. This includes modifying data, adding data, searching the database and generating reports. Usually these operations are easily accomplished in database systems.

Help Facility

This feature allows the user to obtain online help while interacting with the DBMS.

ADVANTAGES OF THE DBMS APPROACH

1. Data Redundancy is reduced considerably thereby solving problems of excessive memory requirements and data inconsistencies.
2. Programming effort is also reduced considerably because of the built-in capabilities of the DBMS.
3. Response time is much faster since the end-user can directly interact with the DBMS.
4. Data independence is achieved as the responsibility of knowing the physical

details of data storage lies with the DBMS. The users concentrate on the logical contents of the data.

5. Most databases give the users the freedom to make database design changes very easily. In contrast, in a non DBMS environment, these changes would require considerable programming effort.

6. Due to the features discussed above, significant cost savings are achieved through the use of a DBMS.

7. DBMS's offer a wide variety of security and privacy features which are essential for the success of the system.

FILE STRUCTURES

Some of the commonly used files structures are discussed below:

1. Sequential Files: The sequential file is distinguished by the following characteristics:

   a. In this type of file the records should be accessed in this same order in which they were written. In other words, there is no method by which a particular record can be accessed by skipping other records.

   b. If the file has to be updated and a record has to be modified, then the file has to be rewritten to another file.

   Sequential files are suited for applications which require all file records to be processed at the same time. The most common application is the Payroll system of any organization ,where salaries have to be computed once a month for all the employees. However, for other applications these characteristics of the sequential file may not be acceptable.

2. Random Access Files: Many applications require the records in a file to be accessed in a random manner rather than sequentially. The rail reservation system requires that the booking position should be available in a few seconds. Random access files have this characteristic. Two of the most commonly used random access files are indexed file and index-sequential files. In order to understand these files it is important to understand the concept of record keys.

Consider the example of an employee file in which records of each employee comprising of staff number, name, designation, basic pay are stored. If we wish to find the record of particular employee, then an identifier for that record must exist. This identifier is called the record key. For instance in our example the staff number can be used as an identifier to locate the record of a particular employee. Usually a file must have at least one unique key whose value is taken as the name of the record. This is called the primary key of the file.

It is also possible that one key may not uniquely identify the record. For example, two persons can have the same name as well as the same fathers name. In such a situation, the name, fathers name and the address may be jointly taken as the identifier key. A key thus formed by joining two or more fields is known as a concatenated key. Since this combination uniquely identifies the record it may be used as a primary key.

All other fields which do not uniquely identify the record are termed as secondary keys.

Indexed Files

While using databases one of the method to obtain random access is to create one or more indexes on that file. Since the records of the file are scattered on the disk, an index should be created which will contain a table of values in which the first column contains record key values and the second column contains disk addresses. The keys are arranged sequentially in their column.

Suppose we have an indexed file called EMPLOYEE which is indexed on field called staffno. Since the file is indexed on the primary key ,the index will be called primary key index.

Adding Records to the File Employee

When the file is first opened , the operating system will allocate a block of disk space to it. As records are added to the file , they are written to this block and on filling up of this block a new block is allocated. Whenever a record is written an entry is made in the staffno index which comprises of the key value and the block number into which the record is written (known as the relative address of the record).

A file directory which gives the physical address corresponding to the relative address is also created. Whenever a search is made for the record which contains a specific value for staffno, the index table is read first and the physical address is then cross referenced.

Indexed Sequential Files

In this type of file records are physically stored on the disk in groups. Records are stored sequentially within each group. When each group corresponds to a physical subdivision of the disk such as a track, the file type is known as ISAM. (Indexed Sequential Access Method). In addition to this, with each track, a separate primary key index also maintained. In this arrangement, the ISAM file can be accessed in two ways. i.e. entire file can be read sequentially or alternatively records may be accessed via the index: the index is entered by key value, the address is located within the index and the record is retrieved.

These files are used typically when:

(a) Random access is needed to the records using the primary key.

(b) Frequent access to the file in primary key sequence is also needed.

LOGICAL DATABASE DESIGN

Up to now we have been addressing data without considering the relationships between various data items. In designing for a database it is important to develop a conceptual model of the involved data which states the relationship between the data items. The purpose of this exercise is to group the data into a number of tables in order to reduce data redundancy and avoid addition, deletion and modification anomalies.

ER Analysis

A method called entity-relationship analysis has been used for obtaining the conceptual model of the data, which will finally help us in obtaining our relational database. In order to carry out ER analysis it is necessary to understand and use the following features:

1. Entities: these are the real word objects in an application.

2. Attributes: these are the properties of importance of the entities and the relationships.

3. Relationships: these connect different entities and represent dependencies between them.

In order to understand these terms let us take an example. If a supplier supplies an item to a company, then the supplier is an entity. The item supplied is also an entity. The item and supplier are related with each other are in the sense that the supplier supplies an item. Supplying is thus the verb which specifies the relationship between item and supplier. A collection of similar entities is known as an entity set. Therefore each member of the entity set is described by its attributes.

A supplier could be described by the following attributes:

SUPPLIER [supplier code, supplier name, address] an item would have the following attributes

ITEM [item Code, item name, rate] The Entity Relationship diagram shown in the Figure 14.1 represents entities by rectangles and relationships by a diamond.

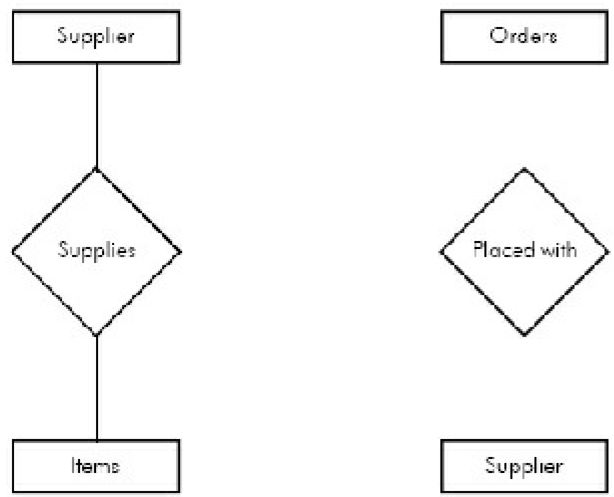


Figure 14.1: The Entity Relationship

Now the problem, that we come across is of identifying entities, which can be in a set. An entity set can have only those items which have same property. To understand in better way, teachers form one entity set and lectures another. The relationship is “take”. Teachers take lectures. Lectures are held in class rooms thus constituting another entity set and the relationship is held “in”.

It is easier to find out the relationships once the entities are identified. That could be made easier by saying that entities are generally “nouns” and the relationships are the “verbs”. One has to use one's commonsense to find out the entities and the relationships.

A single entity can be related to more than one entity. Let us have better understanding by taking one more example-

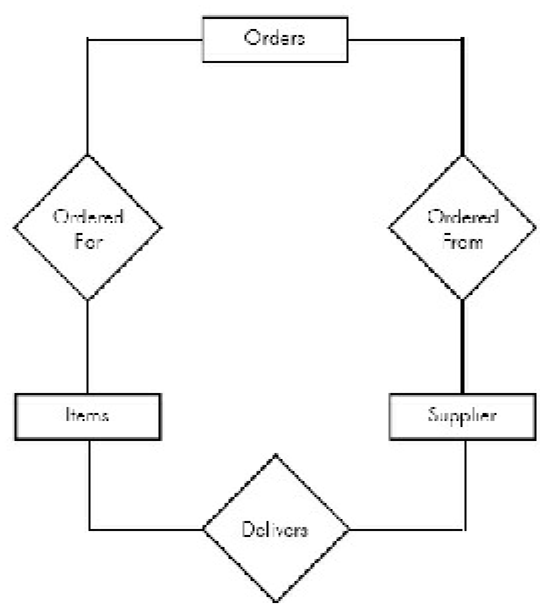
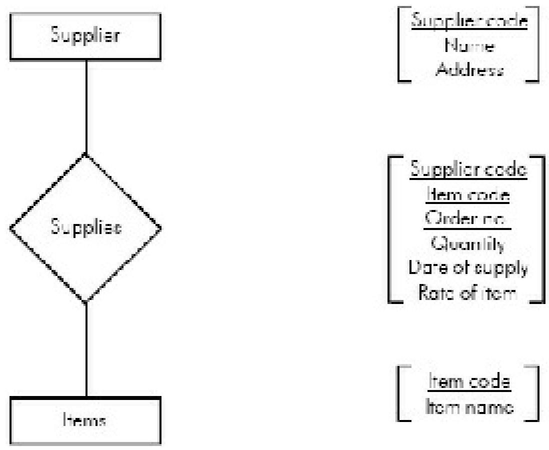


Figure 14.2: The Entity Relationship – An Example

Once the entities and relationships are identified, the next step is to specify the attributes of entities and relationship. For example, the attributes of supplier, are supplier address. Similarly the attributes of entity orders would be order no., order date, whereas the attributes (identification) of both the entities (it connects both) i.e. the item code and the supplier code. Not only that but also the attributes like Order no., Qty. supplied, Date of Supply, Rate of item.

The attributes of the entities and the relationships are shown in the Figure 14.3 also:



The unique attribute from the set of each entity is underlined. One thing to be noted is the same supplier can supply a number of items and same item can be supplied by a number of suppliers. Thus we require both the identifications i.e. supplier code and item code to uniquely specify the quantities of item and the date of supply. Now the supplier may make mistakes in the supply of orders, so the order number is also required.

Let us see all the distributes of all the entities to understand the relationships in a better way:

Orders	[Order No., Order date]
Ordered For	[Order No., Supplier code, Item code, Rate, Date of supply]
Supplier	[Supplier Code, Item code, Order No., Qty, Date of supply, Rate]

Relationships Cardinality and Participation

A relationship cardinality is the number of relationships in which an entity can appear. This cardinality is usually shown on E-R-diagram. An entity can have –

(i) One Relationship

(iii) Fixed number of relationships

(iv) Variable number of relationships.

As we discussed a supplier may supply number of items and the same item may be supplied by number of vendors. This is depicted in the Figure 14.4. There are 2 suppliers say S_1 and S_2. There are items I_1, I_2, I_3...... I_6. Supplies S_1 supplies items I_1, I_2, I_4 and supplier S_2 supplies items I_2, I_3, I_4, I_5 and I_6.

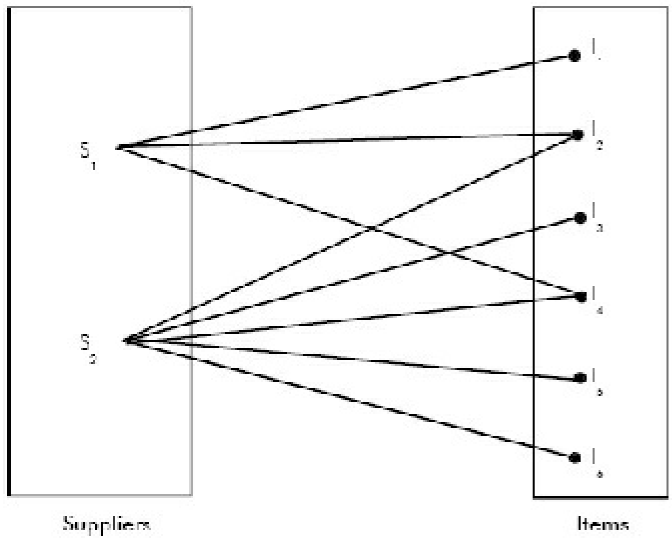
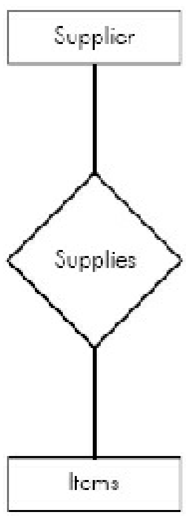


Figure 14.4

Let us associate variables N and M with the entities supplier and items respectively. N varies from S_1 to S_2 and M = I_1 to I_6.



The relationship is illustrated as N:M relationship when one supplier S_1 is supplying 3 items then the relationship N:M becomes 1:3 and if an item is supplied by 2 vendors then it becomes 2:1 relationship.

Till now we have seen that each member in an entity set is participating. But this is true. There are conditions like:

(i) It is necessary for each vendor to supply all the items, then it's participation is compulsory or mandatory.

(ii) It is also possible that each vendor is not required to supply all the items then it's participation is optional

(iii) If a condition is put like the supplier has to supply a particular item if the second vendor is not able to supply the quantity in time then this type of participation is conditional.

RELATIONAL DATABASE SYSTEMS

Usually, a conceptual design cannot be directly implemented on a particular database system. Rather, the design must first be translated into a physical database design or physical model, that conforms to the features of the particular DBMS being used. The reason for this is that each DBMS has its own particular set of data structures for storing and maintaining information and there is often no direct relationship between these structures and those of a particular conceptual model. Thus, a conceptual design, which is built up from entity-types, relationships, constraints and so on, must be recast into forms that can be directly implemented on the DBMS. In other words, they must be recast into a suitable physical database design.

The Relational Database Model

Basic Characteristics: Relational databases have certain characteristics that distinguish them from other types of databases. These are:

- A relational database consists of one or more two-dimensional tables of data values, with very simple rules defining the construction of a tables of data values, with very simple rules defining the construction of a table.
- Relationships between two or more tables is based on a common field, taken as a primary key in one table and foreign key in the other tables.

Definitions: The basic structure of a relational design is the table, known as a relation. Each row of a table, is known as a tuple. Each column of a table contains some data corresponding to a particular row. The terms attributes and columns are used interchangeably.

Rules for Table Construction

- Each row must be unique. This means that no two row should have the same data for every column.
- Each entry in a table in any particular column corresponding to any row should be a single entry.
- The order in which the rows are projected is immaterial.
- Each column should have a name which should closely reflects the entry made in it.

Attributes and Domains

An attribute of a table represents a particular characteristic of the set of facts represented by the table. A related concept that is very useful is the domain of an attribute, which is defined as all of the possible values that may be assumed by the attribute.

Keys: The keys play a very important role in the construction of a complete database application. It is useful to have a primary key in each table which recognizes unique data in each column. There may be a case in which more than one column in the table is unique. In this case all these columns are known as candidate key. Out of this only one is taken as the table key and rest are called as alternate keys.

Often there is a case when no single column in a table is unique. Then there is a possibility that there may be a combination of keys that are unique. So in that case a key has to be concatenated with other keys. In this case the columns are used in combination to represent the table key. This kind of table key is known as the concatenated key.

Functional Dependency: An attribute B is functionally dependent on attribute A if every value of A uniquely determines the value of B. In this case, attribute A is called the determinant of B.

As an example let us consider the following table for which the data is given below:

EMPLOYEE (STAFFNO, NAME, SALARY)

STAFFNO	NAME	SALARY
1234	TARUN	25000.00
1237	SANDEEP	24000.00
1248	VIJAY	34000.00
1276	ASHISH	18000.00

The table represents the data for each employee and the likely choice for the key is STAFFNO. If we look at the table it will be seen that if STAFFNO is known the NAME will be automatically determined. For instance if the STAFFNO is 1276 corresponds to the NAME ASHISH. In such a situation NAME is said to be functionally dependent on STAFFNO. Similarly it can be observed that SALARY is also functionally dependent on STAFFNO. This can be represented as

STAFFNO NAME

SALARY

Functional dependencies are not necessarily symmetric, in a way that B may be functionally dependent on A but this does not necessarily imply A is also functionally dependent on B.

This means that in the EMPLOYEE table STAFFNO uniquely identifies the SALARY of an individual. However many individuals may have the same salary.

A functional dependency can involve more than one attribute in which case a concatenation key is used to depict the functional dependency. For example if a table as shown below exists

ORDER[ORDERNO,ITEMCODE,QTY]

The functional dependency will be

ORDERNO+ITEMCODE QTY.

This is so since QTY is not dependent on ORDERNO or ITEMNO alone but on the combination of both the attributes.

Table Normalization

The tables should be properly designed. If the tables are not pre planned in design, the organization may face a lot of problems in terms of money and time. After the poorly database design, if the tables are implemented, it will be a costly affair to eliminate the problems since this will involve people time and large data storage. To help eliminate these problems, a systematic technique has been developed for translating a conceptual design into a set of well-designed tables. This technique is known as normalization.

Normal Forms

There are some characteristics of the tables, which can be identified. The different combinations of these characteristics are called as the Normal Forms. There are several Normal forms and each normal form has been designed to eliminate some problem associated with the relational tables. Each table undergoes a set of transformations and each transformation changes one normal form to the other.

First Normal Form

The starting point in the normalization process is to have the First Normal Form.

A table is in First Normal Form if:

- No two rows are identical, and
- Each table entry is single-valued

E.g. DEALERS [Name, Dealerid, Location, Orderno, Orderunits, Dateoforder]

The above table can be broken down to three tables in order to have no identical rows and each entry to be single-valued. The column name in bold & underline represent the primary key for that table. It's equivalent foreign key is shown in bold in the other table.

DEALER_NAME [Name, ID, Location]

ORDER [ID, Orderno]

ORDER_DATE [Orderno, Orderunits, Dateoforder]

The above transformation was achieved by

- Identifying a unique key for each entity type, which is the first requirement of the First Normal Form.
- Since the second requirement was that each attribute of the entity type should be single valued, the entity types which contained repeating groups have been removed into different tables.

Second Normal Form

Tables in First Normal Form have characteristics that render them difficult to use. These characteristics are recognized and they are eliminated leading to Second Normal Form.

A table is in Second Normal Form if:

- It is in First Normal Form, and
- Each non-key attribute is functionally dependent on the entire key.

A partial functional dependency is said to exist between two tables attributes A and B if:

- B is functionally dependent on A, and
- A is only part of the table key.

E.g. STUDENT [rollno, name, classno, GPA, Grade]

In the above table suppose each row represents a student enrolled in a class. GPA represents his Grade point average obtained till now. Grade is filled up if the student has completed the class, otherwise it is left blank. Sample data contained in this table is shown below:

Rollno	Name	Classno	GPA	Grade
1	Pragya	MIS	3.5	B+
2	Ashish	Java	4.0	A+
1	Pragya	SSAD	3.5	A
3	Bu	DBMS	3.0	
1	Pragya	DBMS	3.5	A−

By studying the above table it is seen that there are various problems associated. For instance, Roll no., Name and GPA for "Pragya" are entered thrice. This has created a situation of Data Redundancy, which as a rule has to be minimized to the largest extent possible as

- This will increase data storage which is costly.
- Data entry will also increase by duplicating data.
- Data inconsistencies can arise if any of the three entries of :pragya" are incorrectly typed.

Modification Anomalies

Redundant data in a table will always pose various difficulties, that become apparent whenever the data is manipulated, i.e., during addition, deletion or updation. Let us study these with respect to our example.

Deletion Anomaly

Consider a student ,who was enrolled in the college drops out for some reasons from his classes but does not drop out of the college. In this instance we will have to find all rows pertaining to him and will have to delete these rows. However when we do this all basic information of this student will also be deleted from the table. This necessarily implies that as far as our table is concerned the student no longer exists in the college. However this is not so since the student has not dropped out of the college. This is known as deletion anomaly.

Insertion Anomaly

Consider that a new student enrolls in the college but does not join any classes immediately. Since the table has to contain a classno, it will not be possible to enter his name in the table. We could use some special notation in the classno. However this row will have to be removed when the student actually joins, thereby complicating the management of the database. This type of anomaly is known as insertion anomaly.

Updation Anomaly

While updating a particular field, which has changed in the table for a particular student, a search and change method comprising of several records of the student will have to be done. This exercise will be time consuming and prone to human errors, thereby leading to data inconsistencies. This anomaly is known as updation anomaly.

In the above example rank is functionally dependent on the entire key. Name and marks are dependent on only part of the key, as shown below.

rollno + classno → **rank**
rollno → name
marks

So the partial dependencies are removed by splitting off these dependencies into separate new tables, thus finally the tables created are:

STUDENT_NAME [rollno, name, marks]

STUDENT_RANK [rollno, classno, rank]

Third Normal Form

Some of the tables in the second normal form exhibit problems of redundancy and anomalies. These problems can be removed by transforming the table in it's Third Normal Form.

A table is in Third Normal Form if:

- It is in second normal form, and
- It has no transitive dependencies

A transitive functional dependency is set to exist between two table attributes A and B if:

- One of the attributes is functionally dependent on the other, and

- Neither of the attributes is part of the table key.

E.g. STUDENT_INSTRUCTOR [rollno, classno, rank, instr, office]

In the above example rank is functionally dependent on the combination rollno + classno. However, instr is functionally dependent on classno, because each class uniquely determines the instructor, regardless of the students enrolled in the class. Similarly, office is functionally dependent only on classno, because a particular class uniquely determines an office, namely that of the instructor teaching the class. Office is completely functionally dependent on instructor:

rollno + classno → **rank**
classno → instr
office
instr → office

The transitive dependency and its associated problems of data redundancy may be eliminated by the same technique used to remove partial dependencies – by splitting off the dependency into a separate table, as follows:

STUDENT_INSTR [rollno, classno, rank]

CLASS_INSTR [classno, instr]

INSTRUCTOR [instr, office]

The Best Normal Form

The normal forms discussed so far are ideal for the designer to bear in mind. However it is not necessary that a table in any of the above formats is useful. The best normal form can be any of the above given forms, depending on the situation.

It is possible for the designer to make a decision not to convert into third normal form in case the actual situation so demands .i.e. storage considerations etc. Consider the table given below:

FRIEND [NAME, CITY, STATE, PINCODE].

It will be noted that the above table is not in third normal form as transitive dependencies exist. This table could be transformed as follows

PINCODE [CODE, CITY, STATE]

However if this transformation is done , it would involve making a table which contains lakhs of entries. The designer may consider this unnecessary considering the 'number of friends' that have to be dealt with in the application. This sort of trade off is sometimes termed as Best Normal Form.

Boyce-Codd Normal form

For most situation, tables in third normal form are usually free from the problems of data redundancy and anomalies. Occasionally, odd situations arise in which tables in third normal forms may nevertheless be problematical. Because of this, several still higher forms for tables have been defined in order to pin point the sources of the difficulties and to clarify the method of their elimination.

Fourth Normal Form

> A table is in fourth normal form if:
>
> - It is in Boyce-Codd Normal Form, and
> - It does not contain multiple valued dependencies.

A multi-valued dependencies is said to exist between two attributes A and B if for each value of attribute A there is one or more associated values attribute B.

INTRODUCING ORACLE 8 AND ITS FUNDAMENTALS

Most typically, computers store and organize large amount of information within a database. A database, whether or not a computer manages it, is nothing more than an orderly collection of related information. A database safely stores information and organizes it for fast retrieval. Databases come in many varieties. Inverted list, hierarchic and network database models are older type of database systems that, in general, are inflexible and difficult to work with. Relational databases are easy to understand, design, and build. Relational databases store and present all information in tables, an easily understood concept. Furthermore relational databases hide the complexities of data access from the user, making application development relatively simple when compared to other type of database systems. Oracle 8 server adds many new features to extend the power of Oracle Server and make it suitable for even the most demanding and complex application environment.

Every database application is built upon a set of related database objects that store the application's data and allow the application to function. This section introduces Oracle 8 database objects such as tables and views.

Features of Oracle 8

- Database Management Systems.
- New features of Oracle 8.
- Oracle's Network Computing Architecture (NCA).
- Oracle 8 Database Management and security.
- Schemas.
- Tables.
- Datatypes.

- Data Integrity and integrity constraints.
- Views.
- Indexes.
- Data clusters.

Database Management System

A Database Management System (DBMS) is a computer software that manages access to databases. A typical multi-user DBMS performs the following tasks and more:

- A DBMS safely manages shared access to a single database among multiple concurrent users. For example, a DBMS locks data as users add and update information so that users do not destructively interfere with one another's work.
- A DBMS leverages computer resources wisely so that a large number of application users can perform work with fast response times and give maximum productivity.
- A DBMS protects database information in such a way that it can reconstruct work lost due to everything from a simple power outage to catastrophic site disasters.

Oracle 8 is an object-relational database management system (ORDBMS). That is, Oracle 8 is a database server that offers the capabilities of both relational and object-oriented database systems. The goal of this course material is to teach you all about Oracle 8 and how it works.

New Features of Oracle 8

Partitioning Tables and Indexes

Oracle 8's data partitioning feature help to minimize the problems specifically associated with very large tables and indexes. Data partition allows Oracle server to store a large table (and its indexes) in smaller, more manageable partitions (pieces) rather than as one large chunk of data.

Management of Large User Populations

Oracle provides its multithreaded server *(MTS)* process architecture that dramatically reduces the overhead associated with maintaining many concurrent database sessions. Introduced as part of Oracle 7, an MTS server configuration uses a small number of server-side processes to efficiently manage the requests of hundreds or even thousands of connected clients.

Advanced Queueing

Oracle 8's new advanced queueing feature is a database-centric alternative for applications that would like to defer the execution of database transactions. For example, demanding client/server systems might want to queue and defer the execution of low-priority transactions to less taxing off-peak hours.

Parallel Processing Enhancements

Parallel query processing allows Oracle 8 to take full advantage of all available server processors and provide excellent response times for even the most CPU and I/O intensive application queries. Oracle divides a SQL request into subtasks, then allow multiple processors to process subtasks in parallel. Oracle merges results from each subtasks and returns them quickly to the user.

Oracle's Network Computing Architecture

To solve the dilemmas (how do you integrate, manage, and support the various system components originating from different vendors) associated with deploying network-based application environments, Oracle has introduced its Network Computing Architecture *(NCA)*. NCA incorporates the needs of both network-centric computing and object oriented development methods.

Oracle 8 Database Management and Security

Oracle 8 introduces several new features that make database administration easier and more manageable.

Backup and Recovery: Oracle 8 and its companion management tool, Oracle Enterprise Manager, include several new features to make database backup and recovery more automated, easier to use and faster.

Server-Managed Backup and Recovery: An Oracle 8 Server can now maintain detailed information about recent database backups. When a database recovery is necessary, Oracle 8 automatically analyses the state of the database, determines the actions necessary to repair the system and then automatically recovers the damaged database.

Incremental Backups: An incremental database backup can minimize backup time and size because Oracle backs up only the data blocks that have changed since the most recent backup.

Point-In-Time Recovery of Individual Tablespaces: With Oracle 8 administrators can now recover complete databases as well as individual tablespaces to specific point in time.

Password Management: Oracle 8 introduces several new features that allow you to automatically enforce a database security policy's guidelines for user password management. For example, an administrator can configure an Oracle database to automatically verify that a user's new password has sufficient complexity and is not a recycled password.

Schemas – Organizing Database Objects

Database organize related objects within a database *schema*. For example, it's typical to organize all of the tables, views, and other database objects necessary to support an application within a single database schema. This way it's clear that the purpose of a certain table, view, or other database object is to support the corresponding application system.

Schemas, An Entirely Logical Concept: It's important to understand that schemas do not physically organize the storage of database objects. Rather, schemas logically organize related database objects. In other words, the logical organization of database objects within schemas has absolutely nothing to do with the physical storage of database objects.

The logical organization that schemas offer can have practical benefits. For example, consider an Oracle database with two schemas, S1 and S2. Each schema can have a table called T1. Even though the two tables share the same name, they are uniquely identifiable because they are within different database schemas. Using standard dot notation, the complete names for the different tables would be S1.T1 and S2.T2.

The Data Dictionary: Every Oracle database uses a number of system tables, views, and other database objects to keep track of metadata- data about the data itself in a database. This collection of system objects is called the Oracle's database's data dictionary or system catalog. Oracle organizes a database's data dictionary within the SYS schema.

Database Tables

Tables are the basic data structure in any relational database. A table is nothing more than an organized collection of records or rows that all have the same attributes or columns. Figure below illustrates a typical STUDENT table in a relational database.

Each student record in the example STUDENT table has the same attributes, including an ID, a first name, a last name, age, gender and so on.

Rollno	Name	Classno	GPA	Grade
1	Pragya	MIS	3.5	B+
2	Amish	Java	4.0	A
1	Pragya	SSAD	3.5	A
3	Ilsa	DBMS	3.0	-
1	Pragya	DBMS	3.5	A

Tables: A table is a set of records with the same attributes.

When you create tables, the two primary things that you must consider are the following.

- The table's columns, which describe the table's structure.
- The table's integrity constraints, which describe the data that is acceptable within the table.

Columns and Datatypes

When you create a table for oracle database, you establish the structure of the table by identifying the columns that describe the table's attributes. Furthermore every column in a table has a datatype. A columns datatype describes the basic type of data that is acceptable in the column. For example, the STUD_ID column in the STUDENT table uses the basic Oracle datatype NUMBER because the column stores ID numbers.

Oracle supports many fundamental datatypes that you can use when creating a relational database table and its columns. The table below describe the most commonly used Oracle datatypes.

Datatype	Description
CHAR (size)	Stores fixed-length character strings upto 2,000 bytes.
VARCHAR2 (size)	Stores variable-length character strings upto 4,000 bytes.
NUMBER(precision, scale)	Stores any type of number.
DATE	Stores dates and times.
CLOB	Stores single-byte character large objects upto 4 gigabytes
BLOB	Stores binary large objects upto 4 gigabytes

CHAR and VARCHAR2 - Oracle's Character Datatype

Oracle's CHAR and varchar2 are the two most commonly used datatype that a table uses for columns that store character strings. The Oracle datatype CHAR is appropriate for columns that store fixed-length character strings such as two-letter USA state codes. Alternatively, the Oracle datatype VARCHAR2 is useful for columns that store variable length character strings such as names and addresses.

- When a string in a CHAR column is less than the column's size, Oracle pads (appends) the end of the string with blank spaces to create a string that matches the column's size.
- When a string in a VARCHAR2 column is less than the column's maximum size, Oracle stores only the string and does not pad the string with the blanks.

Number- Oracle's Numeric datatype.

Oracle's NUMBER datatype supports the storage of all types of numbers, including integers, floating point numbers, real numbers etc.

Date- Oracle Time-Related datatype.

When you declare a table column with the DATE datatype, the column can store all type of time-related information, including dates and associated times.

CLOBs, BLOBs, and More- Oracle's Multimedia datatypes.

To support content rich applications, Oracle 8 supports several large object (LOB) datatypes that can store unstructured information such as text documents, static images, video, audio and more.

- A CLOB object stores character objects such as documents.
- A BLOB column stores large binary objects such as graphics, video clips, or sound files.

Default column values

When you declare a column for a table, you can also declare a corresponding default column value. Oracle uses the default value of a column when an application inserts a new row in the encompassing table, but omits a value for the column. For example you might indicate that the default value for the ADMISSION_DATE column of the ADMISSION table be the current time when an application creates a entry for a new student.

Unless, you indicate otherwise, the initial default value for a column is a null (an absence of value).

Data Integrity and Integrity Constraints

Data Integrity is a fundamental principle of the relational database mode. When a database has integrity, it is another way of saying that the database contains only accurate and acceptable information.

For example a DATE column can contain valid dates and times, but not numbers or character strings. While simple column datatype are useful for enforcing a basic level of data integrity, there are typically more complex integrity rules that are necessary to enforce in a relational database.

Domain integrity, Nulls and Complex Domains.

Domain Integrity defines the domain of acceptable values for a column. For example in the age column which is defined as an integer, we cannot insert a character value. Besides using column datatype Oracle supports two types of Integrity constraints that allow you to further limit the domain of a column.

- A column can have a NOT NULL constraint to eliminate the possibility of nulls (absent values) in the column.

- You can use a CHECK constraint to declare a complex domain integrity rule as part of a table.

Entity Integrity, Primary keys and Alternate Keys

Entity Integrity ensures that every row in a table is unique. As a result, entity integrity eliminates the possibility of duplicate records in the table and makes every row in the table uniquely identifiable.

Primary Key*:* The primary key of the table ensures its entity integrity. A primary key is a column that uniquely identifies the rows in a table. Typically, tables in a relational database might include an ID column to uniquely identify the student records in a STUDENT table.

A table's primary key is sometimes a *composite key.*: that is, it is composed of more than one column.

Optionally, a table might require secondary levels of entity integrity. Alternate keys are columns or sets of columns that do not contain duplicate values within them. For example, the EMAIL column in an EMPLOYEE table might be an alternate key to guarantee that all employees have unique e-mail addresses.

Referential Integrity and Foreign Keys

Referential Integrity*,* sometimes called relation integrity, establishes the relationships among different columns and tables in a database. Referential integrity ensures that each column value in a foreign key of a child table matches a value in the primary key or an alternate key of a related parent table.

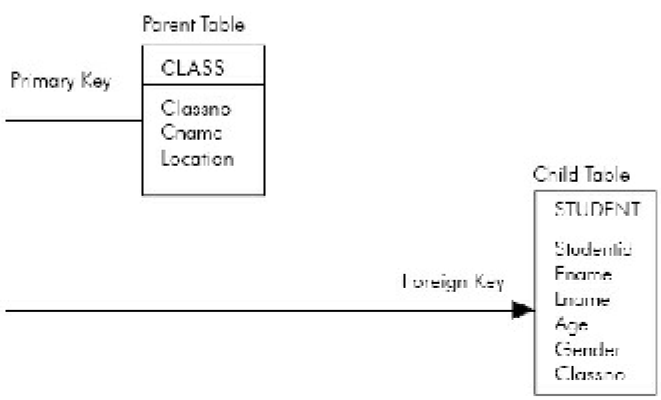


Figure 14.6: Referential Integrity and Foreign Key

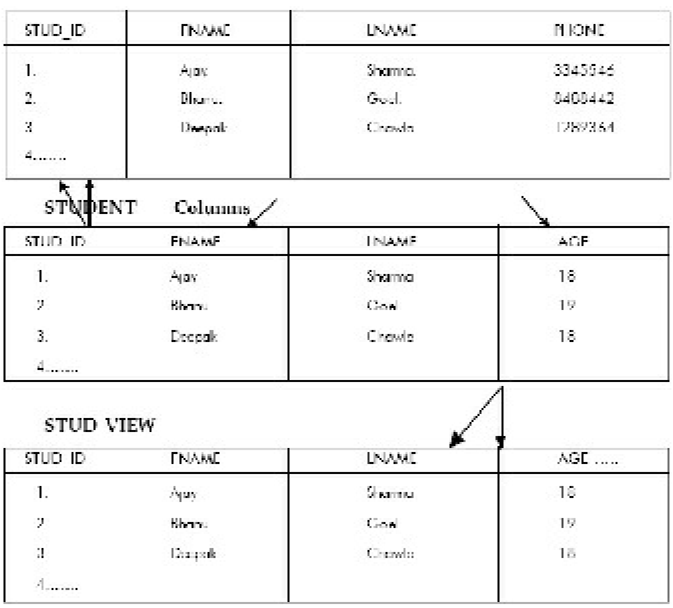
Views- A Different Way of Looking at Table Data

A View is a database object that presents table data. The following examples demonstrate the use of views in a database.

- You can use a simple view to expose all rows and columns in a table. For example, you might create a view called STUD that presents all student records in the STUDENT table.
- You can use view to protect the security of specific table data by exposing only a subset of the rows and/or columns in a table. For example you might create a view called STUD_PH that presents only the first name, last name and the phone number columns and not the age column.
- You can use a view to present derived data that is not actually stored in a table. For example, you might create a view of the ITEMS table with a column called TOTAL that calculates the line total for each record.

  A view is a representation of table data.

  STUD_PH View.



In fact, you can create a view of any data that you can represent with a SQL query. That’s because a view is really just a query that Oracle stores in a database’s data dictionary as a database objects. When an application uses a view to do something, Oracle derives the data of the view based on the view’s defining query.

Indexes-improving the Performance of Table Access

With database applications, performance depends greatly on how fast an application can access table data. Typically, disk I/O is the primary performance determining factor for table access- the less disk I/O that's necessary to access table data, the better the dependent application will perform.

The judicious use of table indexes is the principal method to reduce disk I/O and improve the performance of Table Access. Just like an *index* in a book, an index of a Table column (or set of columns) allows Oracle to quickly find specific table records. When an application queries a table and uses an indexed column in its selection criteria, oracle automatically uses the index to quickly find the target rows with minimal disk I/O. Without an index, Oracle has to read the entire table from disk to locate rows that match the selection criteria.

The presence of an Index for a table is entirely optional and transparent to users and developers of database applications. For example:

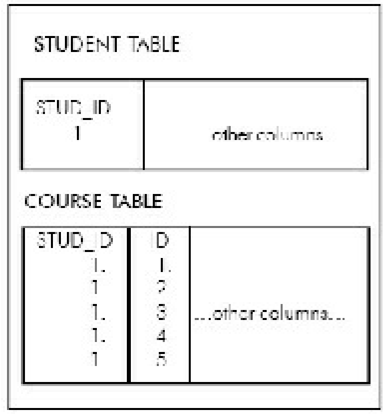
- Applications can access table data with or without associated indexes.
- When an index is present and will help the performance of an application request, Oracle automatically uses the index; otherwise , Oracle ignores the index.
- Oracle automatically updates an index to keep it in synch with its table.

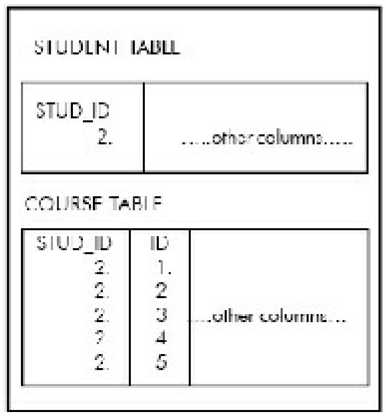
Indexes are meaningful only for the key columns that application requests specifically use to find rows of interest. Furthermore, index maintenance generates overhead- unnecessary indexes can actually slow down down your system rather that improve its performance.

Data Clusters – A Unique Way of Storing Table Data

Oracle 8 also offers data clusters as an alternative to indexing, which can also decrease disk I/O for table access. A data cluster is a unique way of storing table data. In a data cluster, Oracle clusters the related rows of one or more tables together in the same data block.

Each data block in a data cluster holds the related rows for one or more cluster keys.





The motivation of using data cluster is to store on disk the rows that an application commonly uses together. When an application requests the set of rows, Oracle can retrieve the requested rows with perhaps one or a few disk I O's.

For example, you might use a data cluster to "prejoin" the STUDENT and COURSE table. When a application request historical information about a specific student and its courses, Oracle can read the data for a specific student with only one disc I/O. In contrast, when related rows are stored unclustered in random data block across a disk, several disk I/O are necessary to complete the application's request.

SUMMARY

Oracle 8 is certainly a powerful product that you can use to manage information. The very weakness of earlier database systems are exactly why relational database systems now dominate newer information management systems. Oracle 8 builds on the strengths of its predecessor, Oracle 7 server and adds new features to extend its power. Oracle 8 also introduces several new features that make database administration easier and more manageable. It is easier to solve most problems in life when you are organized and have a well defined plan to achieve your goal. Database organize related objects within a database schema. Tables are the basic data structure in any relational database. A table is nothing more than an organized collection of records, or rows, that all have the same attributes, or columns. Every column in a table has a datatype. A columns datatype describes the basic type of data that is acceptable in the column. Data Integrity is a fundamental principle of the relational database mode. When a database has integrity, it is another way of saying that the database contains only accurate and acceptable information. A view is a database object that presents table data. This chapter demonstrated the use of views in a database.

The performance of an application is always critical. That is because the productivity of an application user directly relates to the amount of time that the users must sit idle, while the application tries to complete the work. The use of table indexes is the principal method to reduce the disk I/O and improve the performance of table access.

Oracle 8 also offers data clusters as an alternative to indexing, which can also decrease disk I/O for table access.

PROGRAMMING THE SERVER

SQL is nothing more than a data access language that allows applications to put data into and get data out of an oracle database. In other words, SQL by itself is not a full-featured programming language that you can use to develop powerful database applications. To build a database application, you must use a procedural language that encompasses SQL to interact with an Oracle database.

PL/SQL is Oracle’s own procedural language that can be used to program a Oracle server. By no means is this chapter a complete guide to PL/SQL. However, this chapter does provide an intermediate-level overview of PL/SQL’s capabilities so that you can get started programming an Oracle server.

Features

- PL/SQL Language Basics.
- PL/SQL blocks.
- Program Declarations.

PL/SQL Language Basics

PL/SQL is a procedural programming language that is built into most Oracle products. With PL/SQL, you can build programs that combine PL/SQL procedural statements to control the program flow with SQL statements that access an Oracle database to process information.

For Example, the following is a very simple PL/SQL program that update's a book's unit price given the book's ID number.

```
PROCEDURE update_book_unitprice (book_id IN INTEGER, new_price IN
NUMBER)
IS
Invalid_book EXCEPTION
BEGIN
— AN UPDATE STATEMENT TO UPDATE A DATABASE  RECORD.
UPDATE sales.books
  SET unit_price = new_price
  WHERE id = book_id;
— AN  ERROR-CHECKING STATEMENT
            IF SQL%NOTFOUND THEN
       RAISE invalid_part
       END IF;
       EXCEPTION
— AN ERROR HANDLING ROUTINE
WHEN invalid_book THEN
raise_application_error( -20000, 'Invalid Part ID');
END update_book_unitprice.
```

The example above is a procedure. Using PL/SQL you can build many types of database access program units, including procedures, functions, and packages.

The Basic Programming Constructs that PL/SQL Language Offers

PL/SQL has statements that allow you to declare variables and constants, control program flow, assign and manipulate data, and more. A PL/SQL program is structured using distinct blocks that group related declarations and statements. Each block in a PL/SQL program has a specific task that solves a particular problem. Consequently you can organize a PL/SQL program so that it is easy to understand.

Blocks

A PL/SQL block can include three sections : declarations, the main program body and exception handlers.

- The declaration section of a PL/SQL block is where the block declares all variables, constants, exceptions, etc., that are then accessible to all other parts of the block.
- The main program body contains the executable statements for the block, in other words, the body is where the PL/SQL block defines its functionality.
- The exception handling section contains the exception handlers (error handling routines) for the block. When a statement in the block's body raises an exception (detects an error), it transfers program control to a corresponding exception handler in the exception section for further processing.

Program Declaration

A block in a PL/SQL program can declare many types of constructs.

- Variables and Constants.
- User defined Subtypes.
- User defined composite types, including records, nested tables, and varying arrays.
- Cursors and cursor variables.

Variables and Constants

The following program segment declares a variable and constant using the ANSI datatype INTEGER.

```
DECLARE
student_id INTEGER
standard_fees CONSTANT INTEGER := 7600 ;
….
```

User-defined Subtypes

PL/SQL supports many common subtypes of its base types. A block in a PL/SQL program can also declare *user-defined subtypes* to customize the acceptable domain of values for a variable or constant.

For example, the following program segment declares a user-defined subtype and corresponding variable for book description.

```
DECLARE
Varchar2_50 VARCHAR2(50);
SUBTYPE description IS Varchar2_50;
Current_description Description DEFAULT 'Unknown';
```

This example demonstrates that a program cannot define constrained subtypes directly. Instead, a program must first declare a constrained variable and then a subsequent subtype declaration in order to create the constrained subtype.

User-defined Composite Types

Records

PL/SQL allows a program to create user-defined composite types and then declare variables and constants using the new types. A variable declared with a composite type has distinct components that a program can manipulate individually.

For Example a program can update a particular field in a record variable without updating other fields .

Nested Tables

A program can declare a nested table type to create variables that have one or more columns and an unlimited number of rows, just like tables in database.

FOXPRO

A Brief Overview of FOXPRO

FOXPRO is a relational database in which data is organized into tables. The data can be added, edited and manipulated through a set of simple commands provided with the package. ANSI SQL commands also work on the tables. In the succeeding pages a brief description of the usage of these commands and the rules governing them are described.

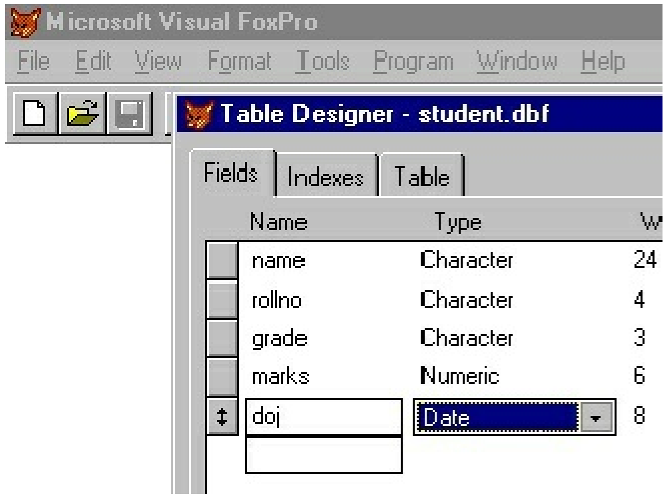
As we know that if we have to get results/ answers to our queries, data has to exist and stored in tables. In order to create a table the following command is entered in the command window:

CREATE [Table name]

This means if we have to create a table named Results our command will be

CREATE RESULTS

FOXPRO will present us a screen to enter Field names, Data type and Field size. Field names should not be more than 8 characters long and should follow the DOS conventions of not containing any blank spaces ,special characters like comma ,slashes etc. However underscore is allowed. The figure below depicts the screen of FOXPRO that will be presented:



Main data types are discussed in brief as given below:

Character: If the data contained in this field will not undergo any computation then define this field as character.

Numeric: The data contained in this field has to be numeric and can undergo any mathematical operation

Date: All dates in the MM/DD/YY format are contained

Logical: Boolean true or False flags are in this type of a field

Memo: If data to entered is more than 254 characters make the field as memo type.

Field size implies the maximum width you want to reserve for any data entered in the field. Note upto 254 characters are allowed.

Once the above have been entered ,then in FOXPRO terminology ,the structure of the table has been created. Pressing CTRL & W together will automatically save the structure. FOXPRO will prompt "enter data y/n. Pressing y will present you with a screen for data entry of all your records. Pressing n will bring you back to the command window.

Modifying the Structure of a Database File

When you create a database file, you may not consider all aspects of the data to be stored. That is, you may forget to include some field or may consolidate information for two fields into one field. We can use modify structure command to amend the structure of the file, at a later stage also.

The modify structure command is used to modify the structure of a database file, it must be open (in use). First of all we open the database file. Then we shall try modify structure.

Use <file name>

Modi struc

Adding More Records with Append

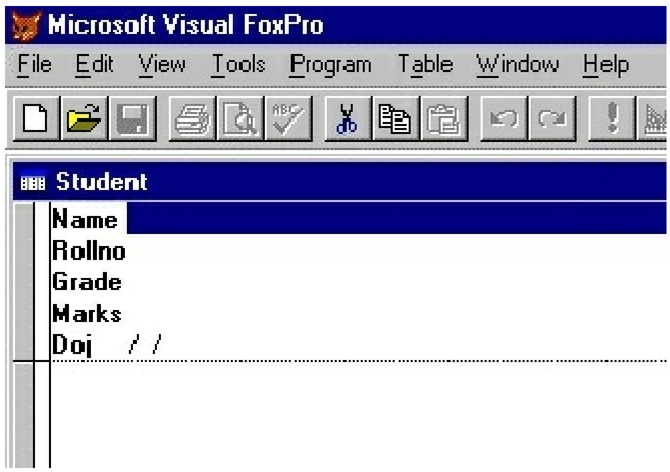
You can add more records at the end of any database file. The command to add records to a database file is append. Before you can add records to a database file with append, the database file must be in use (or open).

Use <file name>

Use student

Append

Foxpro will present a blank form for you to enter a record as under:



SEARCHING FOR SPECIFIC RECORDS WITH LIST

LIST

Continuously displays all/specified fields (and expression) of records of the current database file.

Use <file name>

Use Student

List

This will give a list of all the records of file 'Student' in the table. Note all fields will be displayed. If selective fields have to be displayed the following command should be used:

Use Student

List rollno,name

This will give a list of roll number & name of all the records in this file.

EDITING MULTIPLE RECORDS WITH BROWSE

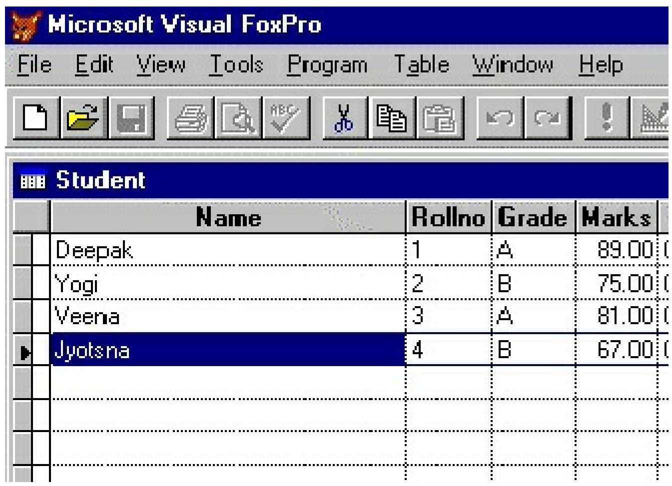
Browse is a different form of Edit (or Change). It displays several records in the form of a horizontal table. Each record occupies one row of the table. You can move the cursor to any field of any record & carry out editing.

Syntax:

Use <file name>

Browse

The browse window will appear as under:



For browsing specific commands use the following command:

BROWSE FIELDS Rollno, Name

REPLACING FIELD CONTENTS WITH REPLACE

The process of making changes with the above commands is very slow as you need to physically select each record, before you can make changes. With the Replace command these changes on all or selected records can be carried out easily.

Syntax:

Use <file name>

Replace rate with rate-1 .

This command will replace the rate field of the current record with a value of rate – 1.

If we wish to replace the rate field of all the records with rate –1, then the following command should be used:

Replace all rate with rate-1

DELETE

Sometimes you may not require a particular record in the file and wish to remove it. This command marks the record for deletion in the active database file. Remember, it does not remove the records physically, but only mark for deletion.

Syntax:

Delete record (record no.)

Delete record 14

If the next 10 records are also to be deleted enter the following command

Delete next 10

PACK

It you wish to remove the records earlier marked for deletion, this command is used. It removes all records marked for deletion and thus reduces the size of the file. After a database has been packed, deleted records can not be recalled, so one has to be careful before using this command.

Syntax:

Pack

RECALL

Unmarked specified records marked for deletion but only if the delete command is not followed by a pack command. After pack we cannot recall the records.

Syntax:

Recall (record no.)

EDIT

Displays the specified /all field of the active database file for editing.

Syntax:

Edit (record no.)

Edit all: This command opens the file from record 1 to the end for editing.

Edit for name="Jyotsna". This command will present all the records whose name field is Jyotsna for editing.

CHANGE

Displays record(s) of the current database file for editing. Same as EDIT.

Syntax:

Change (record.no)

DISPLAY

Displays the contents of record(s) in the current database file and the results of expression.

Syntax:

Display all name,rollno

LOCATE

Sequentially searches the database file for the first record that matches a specified expression.

Syntax:

Locate for name=”Veena”

OPERATORS

Some Mathematical Operators

+ symbol for addition

– symbol for subtraction

/ symbol for division

< symbol for less than

> symbol for greater than

= symbol for equal to.

SOME LOGICAL OPERATORS

.AND. The use of .AND. is : Locate for city =”NEW DELHI” .AND. pin > “110023”

.OR. The use of .OR. is : Locate for city=”NEW DELHI” .OR. pin>”600000”

.NOT. Display next 5 for .NOT. city =”NEW DELHI”

CONDITION

For

If you want to find out the addresses of persons who live in “NEW DELHI” from the database file. Then you need to specify the condition:

LIST FOR CITY=”NEW DELHI”.

SORT

Sort records in the current database file and stores data in a specified new database file.

Syntax:

Use database file

Sort on name to name1

Sorting creates another file with the records sorted in alphabetic or numeric order depending on the key field.

INDEX

Creates an index file or tag for the current database file. Index file or tag helps to display the records of a database in a logical order. INDEX can create the single or compound index file. An extension name of index file is “.idx”

Syntax:

Use database file

Index on name to name_ind

COMPOUND INDEX

A compound index file can hold more than one index file in a single file. Each index file within a compound index file is called an index tag. The extension name of compound index file is “.cdx”

STRUCTURAL COMPOUND FILE

The structural compound index file has the same name as the database file name (with ,cdx as the extension name).

PRINTING REPORTS AND LABELS

You have learnt how to display and print the contents of a data base with list. You will agree that though list retrieves the desire data from the data base file, it is not in presentable form. The list just include field headings followed by the contents of the records and there is no facility to include the descriptive page title, page number, etc. with list, you cannot print selected fields in bold and italic letters. You also cannot display totals or subtotals for numeric fields. However, you can get all these and much more if you use the report feature of FOXPRO. You use the report format file to display, preview or print the desire records from the data base file.

To print a report as per a specific format, a report format file has to be created. This report format file is created with the CREATE REPORT command. This command is used to define report title, footer ,etc. in the format file.

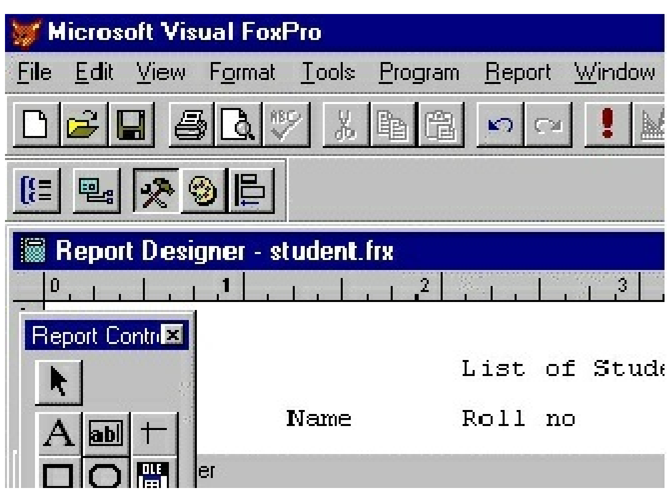
Creating a Report Format

1. Invoke the file menu.
2. Select New from the file menu. Foxpro displays the file type selection dialog box.
3. Select report from the dialog box and then select the OK push button.

When you design a report format foxpro needs a file to save the format. You can define the file name with create report. Otherwise, foxpro will ask for the file name when you save the report.

When create report command is issued a report designing window appears with a tool box and bands for headings, field names, footer etc. Using the appropriate tools from the tool box a report is created and saved. The figure below depicts the actual screen of the command:

Create report student



Previewing Report on Screen

Foxpro enables you to preview the report on the screen while designing its layouts.

1. Invoke the report menu, if required.

2. Select page preview and foxpro displays the first page of your report.

Saving the Report Format

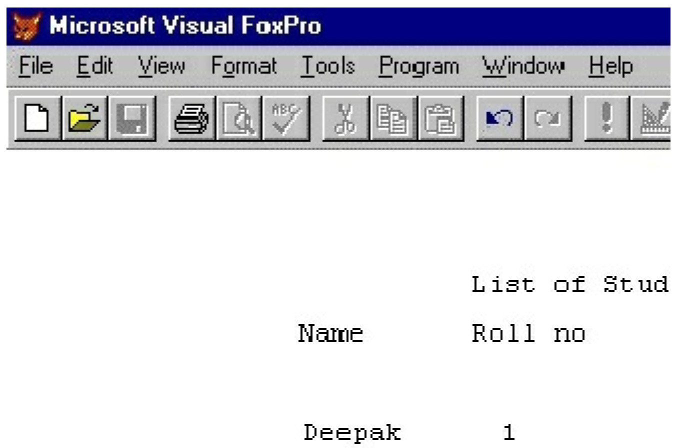
Select save from the file menu or press ^W .

Printing the Report: For printing the report to the screen type the following command:

Report form <file name>

Report form student

This command will display the report as shown below:



To print this report on the printer the command to be used is:

Report form student to print

MEMORY VARIABLES

Creating and using memory variables.

You can create memory variables by using the store command or by equating (=). Let us first learn the store command.

Creating memory variables with store

STORE 20 to BILL

This command creates a memory variable bill and stores 20 in it.

STORE .T. TO PRESENT

STORE .F. TO RAINED

The first command creates a logical type memory variable present and stores .T. in it. The second command creates a memory variable RAINED with .F.

FUNCTIONS

TIME( )

This function returns the system time maintained by DOS.

?TIME( )

Foxpro displays the time in 24 hour format,.i.e.3:48 p.m. is shown as 15:48:00

SECOND( ) and SYS(2)

These two identical functions return the no of seconds that have elapsed since midnight. The only difference between the two is that second( ) returns the no of seconds with a resolution of 1 millisecond

For.e.g.

? seconds( )

42567.227

?sys(2)

42575

DATE( )

The date( ) returns the DOS system date.

?date()

06/23/99

DAY( )

The day() returns the numeric day value from a date expression. The following commands store the current date in a variable current and then day( ) retrieves the day value from current.

STORE.DATE() to CURRENT

23/06/99

?day(current)

23

MONTH( )

The function retrieves the numeric value of the month from any date expression.

For.e.g.

?month(current)

6

Year()

The year() returns the numeric year from a date expression.

For e.g

? year (current)

1999

? year({12/06/99})

1999

DTOC()

The DTOC() (D TO character) function that converts date type data to characters.

Store DTOC (current) to today

23/06/99

ch_date=DTOC(date())

23/06/99

CTOD()

The CTOD() (character to date) is reverse of DTOC(). That is it converts the date stored as character data to date type data.

CH_VAR=”09/08/99"

Store CTOD(CH_VAR) to date_VAR.

ENVIRONMENTAL COMMANDS

SET TALK ON/OFF

Determines whether or not foxpro displays response to certain commands on the screen or the window.

Set status on/off

Displays or remove the status bar. The status bar displays information such as current drive, database file, no. of records, status of special keys etc.

Set bell on/off

Enables or disables sounding of bell during editing.

Set confirm on/off

Specifies whether or not enter or tab must be pressed to exit an input field and move to the next object.

Do

Executes a command or procedure file .

Enddo

Ends a do loop.

IF/ENDIF

Marks the beginning of IF-ENDIF structure. Foxpro executes a set of commands listed between IF and ENDIF if logical condition(s) specified with IF is/are true. This structure may also include ELSE.

DO CASE/ENDCASE

Marks the beginning of a DO CASE-ENDCASE structure. Foxpro executes the first statement block(after DOCASE and before ENDCASE)whose associated conditional CASE statement evaluates to true(.T.).

DO WHILE/ENDDO

Marks the beginning of a DO WHILE-ENDDO loop. Foxpro executes a block of statements within this conditional loop as long as condition(s) specified with DO WHILE is/are true, unless it encounter an EXIT command.

TEXT/ENDTEXT

Marks the beginning of text…endtext block. Foxpro outputs lines of text placed between them to screen, printer of a file. This structure can also include expressions and functions.

MULTIPLE DATABASE FILES

Most of the practical database applications are efficiently managed with multiple database files. That is, the data to be stored in a database file is divided into more than one database file (as you divide the data to be stored in a database file in different fields). This makes the database files small and modular, and leads to modular and efficient program files. It also results in reduced disk space requirement.

Opening Multiple Database Files

You have used the Use command to open a database file. Foxpro displays the name of the open database file in the status bar. You might have noticed that when you open a database file, the previously opened database file is automatically closed. Foxpro replaces the name of the previous database file. This indicates that the previous file has been closed.

Foxpro can open multiple database files if you open them in different *work areas*. The work area is also called the *select area*.

SELECTING A WORK AREA

The select command is used to select a work area. With SELECT, you have to provide the work area reference. You can refer to a work area by its work area number.

Let us open two files in separate work areas. First, open the first file in work area 1.

Select 1

Use <first file name.dbf>

These commands open file.dbf in work area 1. You can also use select A in place of select 1. Next, open second file.dbf in work area 2.

Select 2

Use second file name.dbf

These commands open second file in work area 2.

Linking Databases with Relation

SET RELATION

Establishes relation between two or more open database files on a common field. Can also be used to clear relation between two files.

The first file called the parent file and the second file is called the child file.

If first file has a code and IInd file also has a same code then we can create a relation between both files.

To set the relation, the child database must be indexed on the common field.

Use <file name>

INDEX ON CODE TAG CODE

Then we can create relation between both files.

SELECT A

SET RELATION TO CODE INTO B

THE @ COMMAND

The @ command is one of the most powerful and flexible commands that can be used for several purpose such as

1. To displays the desired data in required format.
2. To input data in a field or variable.
3. To input data through check boxes, radio buttons, push buttons, etc.
4. To draw or clear box and lines.
5. To create custom screen format files, and so on.

Displaying data with the @ command

The @ command can be used to displays any kind of data, such as a field, memory variables or array, result of functions, etc. on the specified position on the screen. The screen of your computer can displays up to 80 columns in each row, where each column displays one character. The screen can display up to 25 rows.

INPUTING DATA WITH @…GET AND @…EDIT

The @..GET (or @…SAY…GET) and @…EDIT are quite similar. These commands in combination with the READ command are used to input data in a field, memory variable or array element.

@…GET

A field or variable name is specified with @…SAY…GET or @…GET. The command displays the current value of the GET variable. Then, the READ command activates GET variable(s) and you can enter the new data.

CLEAR

STORE “Anni Malhotra” to staff

@ 5,5 say “ enter new name “GET staff

now enter read

READ

Activates objects, such as fields, check boxes, lists, popups, buttons, etc. created with @…GET and @…EDIT commands.

Foxpro displays the following message on the screen in row 5.

Enter new name

MENUS AND POPUPS

Introduction to user-defined menu

Foxpro supports two type of menus. The first type of menu is displayed in the first row of the screen. It contains various options in a horizontal bar. This bar is called the menu bar. The various options displayed in the menu bar are called menu pads.

When you select a pad of the foxpro menu system, it displays a few options in a pull down box. A highlighted bar is placed on one of the options, normally the first one. You can move the highlighted bar on the desired option and press enter to select it. Foxpro calls this type of menu just the menu, it is also referred to by various names, such as the pull-down menu, popup menu or simply popup.

Creating a simple menu with @…prompt

You can design a simple menu with the help of @…PROMPT and MENU TO commands. A series of @…PROMPT commands are used to display the various menu options at the desired place on the screen. Then, the MENU TO command invokes the menu and stores the selected option in a specific variables.

Syntax:

@ 3,10 PROMPT " project details "

3 is row and 10 is column.

When you run a program file that contains this syntax, the screen displays a message at 3rd row's 10th column of the screen " project details".

You can link this "project details " with another program file (containing the commands that you want it to perform) so that when you click it, the desired task is performed.

Designing a horizontal menu (Menu Bar)

To define and use a menu bar, foxpro provide the following commands.

DEFINE MENU <menu name>

DEFINE PAD<pad name> OF <menu name>PROMPT <prompt message>

ON SELECTION MENU <menu name>….

ON SELECTION PAD <pad name> OF MENU <menu>…..

ACTIVATE MENU <menu name>

DEACTIVATE MENU<menu name>

DEFINE MENU defines a name for the menu bar.

DEFINE PAD command inserts a pad for the named menu.

ON SELECTION MENU specifies a command, program or procedure that is executed when any pad of the named menu is selected.

ACTIVATE MENU is used to activate a defined menu and you can use DEACTIVATE MENU to de-activate a menu.

Defining and using popup

You have the following commands to define a popup:

DEFINE POPUP<popup name>

DEFINE BAR<bar no>OF<popup name> PROMPT….

ON SELECTION BAR <bar no> OF <pop up name> DO ABC.PRG

ACTIVATE POPUP <pop up name>

DEACTIVATE POPUP <pop up name>

CASE STUDY FOR THE PERSONNEL INFORMATION SYSTEM

*data base files used in the project

REC.DBF

FIELD NAME	TYPE	WIDTH	DEC.
CODE	N	10	
NAME	C	25	
ADD	C	30	
PIN	C	10	
D_O_B	D	8	
OFF	C	10	
RES	C	10	
QUAL	C	10	
DES	C	10	
B_G	C	3	
GRADE	C	2	
S	C	6	
SAL	N	10	2

GRADE.DBF

FIELD NAME	TYPE	WIDTH	DEC.
GRADE	C	2	
PAY	N	6	

SLEA.DBF

FIELD NAME	TYPE	WIDTH	DEC.
GRADE	C	2	
LTC	N	10	
CL	N	10	
ML	N	10	

LEA.DBF

FIELD NAME	TYPE	WIDTH	DEC.
CODE	N	10	
NAME	C	25	
GRADE	C	2	
LTC	N	10	
CL	N	10	
ML	N	10	

LOA.DBF

FIELD NAME	TYPE	WIDTH	DEC
GRADE	C	2	
CAR	N	10	
HOU	N	10	
OTHER	N	10	

LOANS.DBF

FIELD NAME	TYPE	WIDTH	DEC.
CODE	N	10	
NAME	C	25	
GRADE	C	2	
CAR	N	10	
HOU	N	10	
OTHER	N	10	

PROGRAM TO CREATE THE FRONT PAGE OF THE PROJECT (VA.PRG)

```
set talk off
set status off
SET CURSOR OFF
set sysmenu off
set safety off
SET COLOR TO /BG *
CLEAR
SET COLOR TO R+/w  *
defi wind vis from 5,10 to 28,70 FONT 'FOOTLIGHT MT LIGHT', 40 STYLE
    'I' TITLE "MICROSOFT PIS"  GROW MINIMIZE ZOOM
acti wind vis
@0.5,5.5 SAY "PERSONAL"
SET COLOR TO G+/w  *
@1.5,3 SAY "INFORMATION"
SET COLOR TO B+/w  *
@2.5,6 SAY "SYSTEM"
defi wind amit from 25,30 to 27,65
acti wind amit
do spa
wait""
```

```
deac wind amit
deac wind vis
clear all
DO PRO2
Retu
```

PROGRAM TO CREATE THE MAIN MENU OF THE PROJECT(PRO2.PRG)

```
CH=0
CH6=0
SET COLOR TO /BG *
CLEAR
SET COLOR TO
DO WHILE .T.
DEFINE WIND VIS1 FROM 4,25 TO 24,55 TITLE "MAIN MENU" DOUBLE FONT 'IMPACT',5 STYLE 'I'
ACTI WIND VIS1
SET COLOR TO R+/W *
@4,0 PROM "          1. APPEND RECORD    >>    "
@8,0 PROM "          2. DELETE RECORD          "
@12,0 PROM "          3. SHOW RECORD     >>    "
@16,0 PROM "          5. EXIT                  "
menu to ch
DO CASE
CASE CH==1
DEFINE WIND QQ FROM 8.5,55 TO 13.3,70 DOUB FONT 'IMPACT',5  STYLE 'I'
ACTI WIND QQ
@0,0 PROM "NEW RECORD   "
@2,0 PROM "LEAVE RECORD "
@4,0 PROM "LOANS/ADVANCE"
```

```
MENU TO CH6
DO CASE
CASE CH6=1
DEAC WIND QQ
DEACT WIND VIS1
DO APA
CASE CH6=2
DEAC WIND QQ
DEACT WIND VIS1
DO LEA
CASE CH6=3
DEAC WIND QQ
DEACT WIND VIS1
DO LOAN
ENDCASE
CASE CH=3
DEACT WIND VIS1
DO SPRO1
CASE CH=2
DEACT WIND VIS1
DO DEL
CASE CH==4
DEACT WIND VIS1
close all
EXIT
ENDCASE
ch=0
ENDDO
```

```
CLEAR ALL
set sysmenu on
set safety on
retu
```

PROGRAM TO APPEND THE RECORD OF THE NEW EMPLOYEE IN THE DATA BASE FILE (APA.PRG)

```
clear
CLOSE ALL
q=0
SET CURSOR ON
SELE A
USE LEA
SELE B
USE LOA
SELE C
USE REC
Append blank
skip -1
q=code
skip +1
scatter memvar
m.code=q+1
SET COLOR TO B+/W+ *
@4,9 to 28,69 double
SET COLOR TO R+/W+ *
@5,25 say “EMPLOYEE INFORMATION“
SET COLOR TO B+/W+ *
@6,9 TO 6,69 DOUBLE
```

```
SET COLOR TO
@8,12 SAY “CODE :”+str(M.CODE)
CLEAR READ
@9,12 say “NAME :” GET M.NAME pict”@x!”
@10,12 say “ADDRESS :” GET M.ADD pict”@x!”
@11,12 SAY “PIN CODE :” GET M.PIN
@12,12 SAY “STD CODE :” GET M.STD
@13,12 SAY “PH. Nos. : (office) “ GET M.OFF
@14,23 say “(residence) :” GET M.RES
@15,12 SAY “DATE OF BIRTH :” GET M.D_O_B
@16,12 SAY “SEX :” GET M.S pict”@x!”
@17,12 SAY “QUALIFICATION :” GET M.QUAL pict”@x!”
@18,12 SAY “DATE OF JOINING :” GET M.D_O_J
@19,12 SAY “DESIGNATION :” GET M.DES pict”@x!”
@21,12 SAY “GRADE  :” GET M.GRADE pict”@x!”
SET COLOR TO B+/W*
@16,25 SAY “{[MALE],[FEMALE]}”
@20,26 SAY “{[CEO],[M.D.],[MANAGER],[OTHER]}”
@21,25 SAY “{[AA],[A+],[A],[B],[C]}”
SET COLOR TO
@22,12 SAY “SALARY :” GET M.SAL
@23,12 SAY “BLOOD GROUP :” GET M.B_G pict”@x!”
READ
GATHER MEMVAR
SELE A
APPEND BLANK
REPLACE CODE WITH C->CODE
REPLACE NAME WITH C->NAME
```

```
REPLACE GRADE WITH C->GRADE
SELE B
APPEND BLANK
REPLACE CODE WITH C->CODE
REPLACE NAME WITH C->NAME
REPLACE GRADE WITH C->GRADE
CLEAR
CLOSE ALL
RETU
```

PROGRAM TO ENTER THE LEAVE TAKEN BY THE EMPLOYEE(LEA.PRG)

```
CLOSE ALL
SET COLOR TO
CLEAR
A=0
B=0
C=0
R=1
USE LEA
DECLARE P[RECCOUNT()]
DEFI WIND DEL1 FROM 10,20 TO (12+reccount()+1),45 DOUBLE
ACTI WIND DEL1
GOTO TOP
DO WHILE .NOT. EOF()
P[R]=ALLTRIM(STR(CODE))+"  "+ALLTRIM(NAME)+"   "
R=R+1
SKIP
ENDD
@.5,1 MENU P,RECCOUNT(),4
```

```
READ MENU TO CH3
DEAC WIND DEL1
CLEAR
CLOSE ALL
SELE A
USE SLEA
INDEX ON GRADE TAG ASS OF ASS2
SELE B
USE LEA
INDEX ON GRADE TAG ASS1 OF ASS4
SET RELA TO GRADE INTO A
DO WHILE .NOT. EOF()
IF CH3==RECNO()
DEFI WIND LE FROM 5,10 TO 25,70 DOUB TITLE “LEAVE ENTRY” FONT
    ‘TIMES NEW ROMAN’,10 STYLE ‘B’
ACTI WIND LE
@2,5 SAY “CODE :”+”   “+STR(CODE)
@2,30 SAY “NAME :”+”  “+ALLTRIM(NAME) FONT ‘TIMES NEW
    ROMAN’,15 STYLE ‘B U’
@4,5 SAY “LEAVE”
@4,25 SAY “ALLOWED”
@4,45 SAY “TAKEN”
@4,60 SAY “TAKING”
@6,5 SAY “L.T.C.”
@6,25 GET A->LTC
@6,45 GET LTC
@8,5 SAY “C.L.”
@8,25 GET A->CL
@8,45 GET CL
```

```
@10,5 SAY "M.L."
@10,25 GET A->ML
@10,45 GET ML
CLEAR GETS
@6,60 GET A
@8,60 GET B
@10,60 GET C
READ
REPLACE LTC WITH (LTC+A)
REPLACE CL WITH (CL+B)
REPLACE ML WITH (ML+C)
SET CURSOR OFF
@6,45 GET LTC
@8,45 GET CL
@10,45 GET ML
WAIT"" TIMEOUT (5)
DEAC WIND LE
EXIT
ELSE
SKIP
ENDIF
ENDDO
CLEAR
CLOSE ALL
SET CURSOR ON
RETU
```

PROGRAM TO ENTER THE LOANS TAKEN BY THE EMPLOYEE(LOAN.PRG)

```
CLOSE ALL
SET COLOR TO
CLEAR
A=0
B=0
C=0
R=1
USE LOA
DECLARE P[RECCOUNT()]
DEFI WIND DEL1 FROM 10,20 TO (12+reccount()+1),45 DOUBLE
ACTI WIND DEL1
GOTO TOP
DO WHILE .NOT. EOF()
P[R]=ALLTRIM(STR(CODE))+"  "+ALLTRIM(NAME)+"   "
R=R+1
SKIP
ENDD
@.5,1 MENU P,RECCOUNT(),4
READ MENU TO CH3
DEAC WIND DEL1
CLEAR
CLOSE ALL
SELE A
USE LOANS
INDEX ON GRADE TAG SSS OF SSS2
SELE B
USE LOA
INDEX ON GRADE TAG SSS1 OF SSS4
```

```
SET RELA TO GRADE INTO A
DO WHILE .NOT. EOF()
IF CH3==RECNO()
DEFI WIND LE FROM 5,10 TO 25,70 DOUB TITLE "LEAVE ENTRY" FONT
    'TIMES NEW ROMAN',10 STYLE 'B'
ACTI WIND LE
@2,5 SAY "CODE :"+"   "+STR(CODE)
@2,30 SAY "NAME :"+"  "+ALLTRIM(NAME) FONT 'TIMES NEW
    ROMAN',15 STYLE 'B U'
@4,5 SAY "LEAVE"
@4,25 SAY "ALLOWED"
@4,45 SAY "TAKEN"
@4,60 SAY "TAKING"
@6,5 SAY "CAR."
@6,25 GET A->CAR
@6,45 GET CAR
@8,5 SAY "HOUSE"
@8,25 GET A->HOU
@8,45 GET HOU
@10,5 SAY "OTHERS"
@10,25 GET A->OTHER
@10,45 GET OTHER
CLEAR GETS
@6,60 GET A
@8,60 GET B
@10,60 GET C
READ
REPLACE CAR WITH (CAR+A)
REPLACE HOU WITH (HOU+B)
```

```
REPLACE OTHER WITH (OTHER+C)
SET CURSOR OFF
@6,45 GET CAR
@8,45 GET HOU
@10,45 GET OTHER
WAIT”” TIMEOUT (5)
DEAC WIND LE
EXIT
ELSE
SKIP
ENDIF
ENDDO
CLEAR
CLOSE ALL
SET CURSOR ON
RETU
```

PROGRAM TO DELETE THE RECORD OF THE EMPLOYEE(DEL.PRG)

```
SET COLOR TO
CLOSE ALL
USE REC
INDEX ON CODE TAG REC OF REC1
CLEAR
SET CURSOR ON
CH2=0
CH3=0
CO=0
DEFI WIND DEL FROM 8,10 TO 18,60 TITLE “DELETE” FONT ‘IMPACT’,10
ACTI WIND DEL
```

```
DO WHILE .T.
@1,4 PROM “EMPLOYEE CODE” FONT ‘MS SERIF’,8
@3,4 PROM “SHOW” FONT ‘MS SERIF’,8
@3,24 PROMPT “BROWSE” FONT ‘MS SERIF’,8
@3,44 PROMPT “DELETE” FONT ‘MS SERIF’,8
@3,64 PROMPT “CANCEL” FONT ‘MS SERIF’,8
MENU TO CH2
DO CASE
CASE CH2=1
@1,50 GET CO PICT “@9”
READ
CASE CH2= 2
GOTO TOP
SEEK CO
IF FOUND()
DEAC WIND DEL
CLEAR
DO CH23
DO WIN
@1,50 GET CO PICT “@9”
ENDI
CASE CH2= 3
R=1
DECLARE P[RECCOUNT()]
DEFI WIND DEL1 FROM 10,40 TO (12+reccount()),65 DOUBLE
ACTI WIND DEL1
goto top
DO WHILE .NOT. EOF()
```

```
P[R]=ALLTRIM(STR(CODE))+"  "+ALLTRIM(NAME)
R=R+1
SKIP
ENDD
@.5,1 MENU P,RECCOUNT(),4
READ MENU TO CH3
DEAC WIND DEL1
CLEAR
GOTO TOP
DO WHILE .NOT. EOF()
    IF CH3=RECNO()
    CO=CODE
    @1,50 GET CO PICT "@9"
    EXIT
    ENDI
    SKIP
ENDDO
CASE CH2=4
DELETE
PACK
EXIT
CASE CH2= 5
RECALL ALL
EXIT
ENDCASE
ENDDO
DEAC WIND DEL
SET COLOR TO
```

```
CLEAR
RETU
PROCEDURE CH23
SCATTER MEMVAR
SET COLOR TO R/W*
@1,2 TO 30,78 DOUBLE
SET COLOR TO B+/W*
@3,28 SAY “RECORD TO BE DELETED” FONT ‘IMPACT’,15 STYLE’I’
@5,26 TO 5,50 DOUBLE
SET COLOR TO w/w*
@4,60 SAY “CODE :” FONT ‘IMPACT’,10
@7,6 SAY “NAME :” font ‘ms serif’,13
@7,50 SAY “DATE OF BIRTH :” font ‘ms serif’,13
@9,6 SAY “ADDRESS :” font ‘ms serif’,13
@11,6 SAY “PIN. :” font ‘ms serif’,13
@11,27 SAY “STD CODE :” FONT ‘MS SERIF’,13
@11,50 SAY “SEX :” FONT ‘MS SERIF’,13
@13,6 SAY “PH. NOS. :” font ‘ms serif’,13
@13,16 SAY “(OFF.)-” font ‘ms serif’,13
@13,50 SAY “(RES.)-” font ‘ms serif’,13
@15,6 SAY “QUALIFICATION :” font ‘ms serif’,13
@17,6 SAY “DATE OF JOINING :” font ‘ms serif’,13
@17,50 SAY “RETI_MENT DATE :” font ‘ms serif’,13
@19,6 SAY “DESIGNATION :” font ‘ms serif’,13
@21,6 SAY “DEPARTMENT :” font ‘ms serif’,13
@23,6 SAY “SALARY :” font ‘ms serif’,13
@25,6 SAY “BLOOD GROUP :” FONT ‘MS SERIF’,13
SET COLOR TO B+/W*
```

```
@4,65 SAY M.CODE FONT 'IMPACT',10
@7,14 SAY M.NAME FONT 'MS SERIF',13
@7,67 SAY M.D_O_B FONT 'MS SERIF',13
@9,17 SAY M.ADD FONT 'MS SERIF',13
@11,15 SAY M.PIN FONT 'MS SERIF',13
@11,39 SAY M.STD FONT 'MS SERIF',13
@11,57 SAY M.STD FONT 'MS SERIF',13
@13,25 SAY M.OFF FONT 'MS SERIF',13
@13,59 SAY M.RES FONT 'MS SERIF',13
@15,25 SAY M.QUAL FONT 'MS SERIF',13
@17,25 SAY M.D_O_J FONT 'MS SERIF',13
*@17,67 SAY B FONT 'MS SERIF',13
@19,21 SAY M.DES FONT 'MS SERIF',13
@21,20 SAY M.DEPT FONT 'MS SERIF',13
@23,16 SAY M.SAL FONT 'MS SERIF',13
@25,21 SAY M.B_G FONT 'MS SERIF',13
WAIT""
CLEAR
SET COLOR TO
RETU
PROCE WIN
DEFI WIND DEL FROM 8,10 TO 18,60 TITLE "DELETE" FONT 'IMPACT',10
ACTI WIND DEL
RETU
```

PROGRAM TO CREATE THE SUB MENU OF THE PROJECT(SPRO1.PRG)

```
CLEARCLOSE ALLCH1=0DEFI WIND VIS2 FROM 4,20 TO 26,60 DOUBLE
    TITLE "SUB MENU" FONT 'FOOTLIGHT MT LIGHT' ,20 STYLE 'I'
ACTI WIND VIS2
```

```
SET COLOR TO B*/W +
@1,5 PROM " 1. LIST OF EMPLOYEE  "
@2,5 PROM " 2. BIO-DATA OF  EMPLOYEE  "
@3,5 PROM " 3. RETIREABLE  EMPLOYEE  "
@4,5 PROM " 4. ELIGIBILITY LIST  >>  "
@5,5 PROM " 5. INCREMENT LIST  "
@6,5 PROM " 6. LEAVE INFORMATION  "
@7,5 PROM " 7. ADVANCE/LOAN LIST  "
MENU TO CH1
DO CASE
CASE CH1==1
R=3
DEAC WIND VIS2
CLEAR
DEFI WIND VIS3 FROM 4,20 TO 26,60 DOUBLE TITLE "SUB MENU"
     FONT 'FOOTLIGHT MT LIGHT' ,12 STYLE 'I'
ACTI WIND VIS3
USE REC
@1,2 SAY "CODE                NAME"
DO WHILE .NOT. EOF()
@R,3 SAY ALLTRIM(STR(CODE))
@R,17 SAY NAME
R=R+2
IF R>=12
WAIT""
@2,0 CLEAR TO 20,40
R=3
*@1,5 SAY "CODE         NAME"
ENDIF
```

```
SKIP
ENDDO
WAIT”””
DEAC WIND VIS3
CLEAR
CASE CH1=2
DEAC WIND VIS2
CLEAR
USE REC
R=1
DECLARE P[RECCOUNT()]
DEFI WIND DEL1 FROM 10,20 TO (12+reccount()),45 DOUBLE
ACTI WIND DEL1
GOTO TOP
DO WHILE .NOT. EOF()
P[R]=ALLTRIM(STR(CODE))+”  “+ALLTRIM(NAME)
R=R+1
SKIP
ENDD
@.5,1 MENU P,RECCOUNT(),4
READ MENU TO CH3
DEAC WIND DEL1
CLEAR
GOTO TOP
DO RES WITH CH3
CASE CH1==3
DEAC WIND VIS2
DO RET
```

```
CASE CH1==4
DEAC WIND VIS2
DO ELI
CASE CH1==5
DEAC WIND VIS2
DO INC
CASE CH1==6
DEAC WIND VIS2
DO LEA1
CASE CH1==7
DEAC WIND VIS2
DO LOAN1
ENDCASE
CLEAR
RETU
```

PROGRAM TO SHOW THE BIO-DATA OF THE EMPLOYEE(RES.PRG)

```
PARAMETER CH3
CLEAR
SET CURSOR OFF
*a={00/00/58}
*USE REC
DO WHILE .NOT. EOF()
IF CH3==RECNO()
SCATTER MEMVAR
SET COLOR TO R/W*
@1,2 TO 30,78 DOUBLE
SET COLOR TO B+/W*
@3,28 SAY "EMPLOYEE BIO_DATA" FONT 'IMPACT',15 STYLE'I'
```

```
@5,26 TO 5,50 DOUBLE
SET COLOR TO w/w*
@4,60 SAY “CODE :” FONT ‘IMPACT’,10
@7,6 SAY “NAME :” FONT ‘MS SERIF’,13
@7,50 SAY “DATE OF BIRTH :” FONT ‘MS SERIF’,13
@9,6 SAY “ADDRESS :” FONT ‘MS SERIF’,13
@11,6 SAY “PIN. :” FONT ‘MS SERIF’,13
@11,27 SAY “STD CODE :” FONT ‘MS SERIF’,13
@11,50 SAY “SEX :” FONT ‘MS SERIF’,13
@13,6 SAY “PH. NOS. :” FONT ‘MS SERIF’,13
@13,16 SAY “(OFF.)-” FONT ‘MS SERIF’,13
@13,50 SAY “(RES.)-” FONT ‘MS SERIF’,13
@15,6 SAY “QUALIFICATION :” FONT ‘MS SERIF’,13
@17,6 SAY “DATE OF JOINING :” FONT ‘MS SERIF’,13
@17,50 SAY “RETI_MENT DATE :” FONT ‘MS SERIF’,13
@19,6 SAY “DESIGNATION :” FONT ‘MS SERIF’,13
@21,6 SAY “DEPARTMENT :” FONT ‘MS SERIF’,13
@23,6 SAY “SALARY :” FONT ‘MS SERIF’,13
@25,6 SAY “BLOOD GROUP :” FONT ‘MS SERIF’,13
SET COLOR TO B+/W*
@4,65 SAY M.CODE FONT ‘IMPACT’,10
@7,14 SAY UPPER(M.NAME) FONT ‘MS SERIF’,13
@7,67 SAY M.D_O_B FONT ‘MS SERIF’,13
@9,17 SAY UPPER(M.ADD) FONT ‘MS SERIF’,13
@11,15 SAY M.PIN FONT ‘MS SERIF’,13
@11,39 SAY M.STD FONT ‘MS SERIF’,13
@11,57 SAY UPPER(M.S) FONT ‘MS SERIF’,13
@13,25 SAY M.OFF FONT ‘MS SERIF’,13
```

```
@13,59 SAY M.RES FONT ‘MS SERIF’,13
@15,25 SAY UPPER(M.QUAL) FONT ‘MS SERIF’,13
@17,25 SAY M.D_O_J FONT ‘MS SERIF’,13
*@17,67 SAY B FONT ‘MS SERIF’,13
@19,21 SAY UPPER(M.DES) FONT ‘MS SERIF’,13
@21,16 SAY M.SAL FONT ‘MS SERIF’,13
@23,21 SAY UPPER(M.B_G) FONT ‘MS SERIF’,13
EXIT()
ELSE
SKIP
ENDIF
ENDDO
WAIT””
CLEAR
SET COLOR TO
RETU
```

PROGRAM TO SHOW THE RETIREMENT DATE OF EMPLOYEES(RET.PRG)

```
CLEAR
CLOSE ALL
R=3
AR=”CODE NAME D_O_B_O_R”
USE REC
DEFI WIND VIS4 FROM 4,10 TO 26,70 DOUBLE TITLE “RETIREMENT DATE” FONT
‘MATURA MT SCRIPT CAPIT’,10 STYLE ‘I’
ACTI WIND VIS4
@1,3 GET AR
DO WHILE .NOT. EOF()
```

```
@R,3 SAY ALLTRIM(STR(CODE))
@R,13 SAY NAME
@R,40 SAY D_O_B
@R,60 SAY GOMONTH(D_O_B,720)
R=R+1
IF R>=15
WAIT””
@2,0 CLEAR TO 22,60
R=3
ENDIF
SKIP
ENDDO
WAIT””
DEAC WIND VIS4
CLEAR
```

PROGRAM TO SHOW THE EMPLOYEES’S NAME WHO HAVE THE SENIORITY OF MORE THAN OR EQUAL TO 4 YEAR (ELI.PRG)

```
CLEAR
CLOSE ALL
D=0
AR=” CODE NAME D_O_J SENIROTY_YEAR”
R=3
DEFI WIND VIS5 FROM 4,10 TO 26,70 DOUB TITLE
    “ELIGIBILITY(SENIROTY)” FONT ‘COMIC SCANS MS’,8 STYLE ‘B’
ACTI WIND VIS5
USE REC
@1,3 GET AR
DO WHILE .NOT. EOF()
D=(YEAR(DATE())-YEAR(D_O_J))
```

```
IF D>4
@R,5 SAY ALLTRIM(STR(CODE))
@R,14 SAY UPPER(NAME)
@R,40 SAY D_O_J
@R,63 SAY D
R=R+1
IF R>=15
WAIT””
@2,0 CLEAR TO 22,60
R=3
ENDIF
ENDIF
SKIP
ENDDO
WAIT””
DEAC WIND VIS5
CLEAR
```

PROGRAM TO THE INCREMENT AMOUNT OF THE EMPLOYEES AND INCREASE THE SALARY AT 01.04.1999 (INC.PRG)

```
CLOSE ALL
CLEAR
C=” NAME SALARY GRADE SCALE”
D=”01/04/99"
R=3
SELE A
USE GRADE
INDEX ON GRADE TAG GRA OF VIS2
SELE B
```

```
USE REC
INDEX ON GRADE TAG GRADE OF VIS1
SET RELA TO GRADE INTO A
DEFI WIND AMIT1 FROM 4,10 TO 26,70 DOUB TITLE “INCREMENT
    INFORMATION” FONT ‘MS SCANS SERIF’,10 STYLE ‘I’
ACTI WIND AMIT1
DO WHILE .NOT. EOF()
@1,0 GET C
IF DATE()==CTOD(D)
REPALACE SAL WITH SAL+A->GRADE
ENDIF
@R,2 SAY UPPER(NAME)
@R,30 SAY SAL
@R,50 SAY GRADE
@R,62 SAY A->PAY
R=R+2
IF R>13
WAIT””
R=3
CLEAR
ENDIF
SKIP
ENDDO
WAIT””
DEAC WIND AMIT1
CLEAR
RETU
```

PROGRAM TO SHOW THE LEAVE DETAILS OF THE EMPLOYEE(LEA1.PRG)

```
CLOSE ALL
SET COLOR TO
SET CURSOR OFF
CLEAR
A=0
B=0
C=0
R=1
USE LEA
DECLARE P[RECCOUNT()]
DEFI WIND DEL1 FROM 10,20 TO (12+reccount()+1),45 DOUBLE
ACTI WIND DEL1
GOTO TOP
DO WHILE .NOT. EOF()
P[R]=ALLTRIM(STR(CODE))+”  “+ALLTRIM(NAME)+”   “
R=R+1
SKIP
ENDD
@.5,1 MENU P,RECCOUNT(),4
READ MENU TO CH3
DEAC WIND DEL1
clear
CLOSE ALL
SELE A
USE SLEA
INDEX ON GRADE TAG ASS OF ASS2
SELE B
USE LEA
```

```
INDEX ON GRADE TAG ASS1 OF ASS4
SET RELA TO GRADE INTO A
DO WHILE .NOT. EOF()
IF CH3==RECNO()
DEFI WIND LE FROM 5,10 TO 25,70 DOUB TITLE “LEAVE ENTRY” FONT
    ‘TIMES NEW ROMAN’,10 STYLE ‘B’
ACTI WIND LE
@2,5 SAY “CODE :”+”   “+STR(CODE)
@2,30 SAY “NAME :”+”  “+ALLTRIM(NAME) FONT ‘TIMES NEW
    ROMAN’,15 STYLE ‘B U’
@4,5 SAY “LEAVE”
@4,25 SAY “ALLOWED”
@4,45 SAY “TAKEN”
@4,60 SAY “LEFT”
A=A->LTC-LTC
B=A->CL-CL
C=A->ML-ML
@6,5 SAY “L.T.C.”
@6,25 GET A->LTC
@6,45 GET LTC
@6,60 GET A
@8,5 SAY “C.L.”
@8,25 GET A->CL
@8,45 GET CL
@8,60 GET B
@10,5 SAY “M.L.”
@10,25 GET A->ML
@10,45 GET ML
@10,60 GET C
```

```
CLEAR GETS
WAIT””
DEAC WIND LE
EXIT
ELSE
SKIP
ENDIF
ENDDO
CLEAR
CLOSE ALL
SET CURSOR ON
RETU
```

PROGRAME TO SHOW THE LOANS DETAILS OF THE EMPLOYEE(LOAN1.PRG)

```
CLOSE ALL
SET COLOR TO
SET CURSOR OFF
CLEAR
A=0
B=0
C=0
R=1
USE LOA
DECLARE P[RECCOUNT()]
DEFI WIND DEL1 FROM 10,20 TO (12+RECCOUNT()+1),45 DOUBLE
ACTI WIND DEL1
GOTO TOP
DO WHILE .NOT. EOF()
```

```
P[R]=ALLTRIM(STR(CODE))+"  "+ALLTRIM(NAME)+"   "
R=R+1
SKIP
ENDD
@.5,1 MENU P,RECCOUNT(),4
READ MENU TO CH3
DEAC WIND DEL1
CLEAR
CLOSE ALL
SELE A
USE LOANS
INDEX ON GRADE TAG AS OF AS2
SELE B
USE LOA
INDEX ON GRADE TAG AS1 OF AS4
SET RELA TO GRADE INTO A
DO WHILE .NOT. EOF()
IF CH3==RECNO()
DEFI WIND LE FROM 5,10 TO 25,70 DOUB TITLE "LEAVE ENTRY" FONT
    'TIMES NEW ROMAN',10 STYLE 'B'
ACTI WIND LE
@2,5 SAY "CODE :"+"   "+STR(CODE)
@2,30 SAY "NAME :"+"  "+ALLTRIM(NAME) FONT 'TIMES NEW
    ROMAN',15 STYLE 'B U'
@4,5 SAY "LOANS"
@4,25 SAY "ALLOWED"
@4,45 SAY "TAKEN"
@4,58 SAY "TO BE TAKEN"
A=A->CAR-CAR
```

```
B=A->HOU-HOU
C=A->OTHER-OTHER
@6,5 SAY "CAR"
@6,25 GET A->CAR
@6,45 GET CAR
@6,60 GET A
@8,5 SAY "HOUSE"
@8,25 GET A->HOU
@8,45 GET HOU
@8,60 GET B
@10,5 SAY "OTHERS"
@10,25 GET A->OTHER
@10,45 GET OTHER
@10,60 GET C
CLEAR GETS
WAIT""
DEAC WIND LE
EXIT
ELSE
SKIP
ENDIF
ENDDO
CLEAR
CLOSE ALL
SET CURSOR ON
RETU
```

REVISION EXERCISES

Fill in the blanks

1. A ……… is a collection of database that appears to an application as a single, local database.
2. ……… is the copying and maintaining of database objects in multiple databases of a distributed database system.
3. Schemas ………. Organize related database objects.
4. ………. Stores fixed-length character strings up to 2,000 bytes.
5. ………. Is a Oracle's Time-Related datatype.
6. …………. Integrity defines the domain of acceptable values for a column.
7. The primary key of a table ensures its ………… Integrity.
8. Database applications can use a …………….. view to retrieve corresponding table data, but cannot insert, update, or delete table data through a …………… view.
9. The default and the most common type of index for a Table column is a ………….. index.
10. In a ……………, Oracle clusters the related rows of one or more tables together in the same data block.
11. PL/SQL is Oracle's own …………….. that can be used to program a Oracle Server.
12. PL/SQL is a procedural language that is very similar to …………….
13. A PL/SQL block can include three sections : ………………………………….

Answers

1. Distributed database 2. Replication
3. logically 4. CHAR
5. DATE 6. Domain
7. Entity
8. Read-only, Read-only
9. B-Tree index
10. Data clusters
11. Procedural Language.
12. Ada.
13. Declarations, the main program body, and exception handlers.

State True or False

1. Decision support (DSS) are applications that process many small update transactions such as banking, reservations and order-entry systems.
2. Oracle 8 is an object-relational database management system (ORDBMS).
3. Data dictionary and system catalog are the same things.
4. A CLOB column stores large binary objects such as graphics, video clips, or sound files.
5. Referential Integrity is sometimes called as relation integrity.
6. Foreign key is a second level of entity integrity.
7. Oracle automatically updates its index to keep it in synch with its table.
8. We should index every column of the table.
9. Another indexing option for a column in a table is a bitmap index.
10. The motivation for using a data cluster is to store on disk the rows that an application, commonly uses together.
11. SQL by itself is a full-featured programming language that you can use to develop powerful database applications.
12. PL/SQL programs are not limited to one block.

13. A program variable or constant can use only Oracle or ANSI/ISO datatype.

Answers

1.	False	2.	True
3.	True	4.	False
5.	True	6.	False
7.	True	8.	False
9.	True	10.	True
11.	False	12.	True
13.	True		

Choose the correct one

1. Databases come in many varieties.
   a) Inverted List
   b) Hierarchic
   c) Relational
   d) All the above
2. Which datatype stores variable-length character.
   a) CHAR
   b) VARCHAR2
   c) NUMBER
   d) DATE
3. A tables's Primary Key is sometimes called as a ………… Key when it is composed of more than one column.
   a) Composite
   b) Alternate
   c) Foreign
   d) Main
4. The presence of an index for a table is:
   a) Compulsory
   b) Entirely optional

c) For Primary keys

d) None of the above

5. In a data cluster, the related ………. of one or more tables together in the same data block.

a) Rows

b) Columns

c) Tables

d) None of the above

6. A single line comment is

a) /* Comments */

b) — Comments.

c) __ Comments

d) None of the above.

Answers

1.	(d)	2.	(b)
3.	(a)	4.	(b)
5.	(a)	6.	b)

Match the following

1.	Database object	a.	Primary key
2.	Columns	b.	Foreign key
3.	CHAR	c.	Datatype
4.	Entity integrity	d.	Table
5.	Relation integrity	e.	Attributes

Answers

1.	(d)	2.	(e)
3.	(c)	4.	(a)
5.	(b)		

Answer the following

1. What are the different types of common business application environment for a database server?.
2. What is Replication.
3. Explain the concept of logical versus physical organization with respect to how operating systems organize files on disks.
4. Write a note about the specific types of views that Oracle supports.
5. What is the appropriate use of the B-Tree index.
6. What is the version of PL/SQL supported by Oracle 8 ?
7. Write short note on Program Comments in PL/SQL ?
8. What is a record type.

Answers

1. The different types of common business application environment are:
    - Online transaction processing (OLTP) applications: applications that process many small update transactions such as banking, reservation, and order-entry systems.
    - Decision support (DSS) applications: applications that query targeted information from a database for the purpose of data analysis.
    - Data Warehousing applications: applications that access large, read-only databases that are specifically optimized for fast access to even the most complex bits of information.
2. Replication is the copying and maintaining of database objects in multiple databases of distributed database system. Replication can improve the performance and protect the availability of database applications because alternate access options exists. For example, an application can normally access a local database rather than a remote server to minimize network traffic and achieve maximum performance. However, if the local database server experiences a failure, the application can continue to function because other servers with replicated data remain accessible.
3. The layout of file folders and files in a graphical file management utility, such as the Microsoft Windows Explorer, does not necessarily correspond to the physical location of the folders and files on a particular disk drive. File folders represent the logical organization of operating system files. The underlying operating system decides where to physically store the blocks for each operating system file, independent of the logical organization of encompassing file folders.

4. The specific types of views that Oracle 8 supports are:

Read-Only Views

Applications can use Read-Only views to retrieve corresponding table data, but cannot insert, update or, delete table data through a read-only view.

Updatable Views

Application can use updatable views to insert, update, and delete table data as well as query data.

Oracle 8 also allows you to define updatable views that an application can use to insert, update, and delete table data as well as query data.

5. B-Tree indexes are not appropriate for all types of applications and all types of columns in a Table. In general, B-Tree indexes are best choice for OLTP applications where data is constantly being inserted, updated and deleted. In such environments, B-Tree indexes work best for key columns that contain many distinct values relative to the total number of key values in the column. The primary and the alternate key are the best examples of columns that should have B-Tree indexes.

Conveniently, Oracle 8 automatically creates B-Tree indexes for all PRIMARY KEY and UNIQUE integrity constraints of a Table.

6. Oracle 8 server supports PL/SQL version 3.

7. Program Comments: All blocks of a PL/SQL program should include comments that document program declaration and functionality. Comments clarify the purpose of specific programs and code segments.

PL/SQL supports two different types of comments, as the following code segment shows.

```
— PRECEDE A SINGLE LINE COMMENT WITH A DOUBLE HYPHEN.
/* THIS IS A MULTILINE COMMENT
LINE 1
LINE 2… */
```

8. A record type is a group of related fields, each of which has its own name and datatype. Typically, PL/SQL programs use a record type to create variables and match all or a subset of table columns. For example, the following code segment declares a user-defined record type to match the attributes of the BOOK table, and then declares a variable using the new type.

```
DECLARE
```

```
TYPE book_record IS RECORD (
Id INTEGER,
unit_price NUMBER(10,2),
description VARCHAR(200)
);
current_book book_record;
………
```

ID	UNIT_PRICE	DESCRIPTION
[illegible]	34.70	Oracle Architecture

The figure illustrates the structure of the example CURRENT_BOOK variable after each filed has been assigned a value.

Chapter 15: SQL

SQL*PLUS : GETTING STARTED

The easiest way to learn about SQL is by using SQL*Plus. So let's begin by logging into SQL*Plus. We have given all the examples based on four tables, Student_detail, student_class, student_ marks and student_rank. The structure and data contents of these four tables are given below:

Table 1 : student_detail

SQL> desc student_detail;

Name	Null?	Type
ROLLNO	NOT NULL	VARCHAR2(3)
NAME		VARCHAR2(10)
AGE		NUMBER(2)

SQL> select * from student_detail;

ROL	NAME	AGE
001	achyut	17
002	dhiru	18
003	kapil	17
004	neeraj	17
005	ravi	16
006	shweta	17
007	tarvinder	18

7 rows selected

Table 2 : student_class

SQL> desc student_class

Name	Null?	Type
ROLLNO	NOT NULL	VARCHAR2(3)
CLASS		VARCHAR2(10)

SQL> select * from student_class;

ROL	CLASS
001	science
002	science
003	arts
004	arts
005	arts
006	science
007	commerce

7 rows selected

Table 3 : student_marks

SQL> desc student_marks

Name	Null?	Type
ROLLNO	NOT NULL	VARCHAR2(3)
MATHEMATICS		NUMBER(5,2)
ENGLISH		NUMBER(5,2)
PHYSICS		NUMBER(5,2)
ACCOUNTANCY		NUMBER(5,2)
HISTORY		NUMBER(5,2)

SQL> select * from student_marks;

ROL	MATHEMATICS	ENGLISH	PHYSICS	ACCOUNTANCY	HISTORY
001	80	67.5	78		
002	63	55.5	56		
003	98.5	76	0	89	
004	54	72		95.5	
005	40	81.5		56.5	
006	78.5	73	67		
007	88	69			78

7 rows selected.

Table 4 : student_rank

SQL> desc student_rank

Name	Null?	Type
ROLLNO	NOT NULL	VARCHAR2(3)
MARKS		NUMBER(6,2)
TOTAL		NUMBER(6,2)
RANK		VARCHAR2(3)

SQL> select * from student_rank;

ROL	MARKS	TOTAL	RAN
001	225.5	300	3
002	174.5	300	7
003	263.5	300	1
004	221.5	300	4
005	178	300	6
006	218.5	300	5
007	235	300	2

7 rows selected.

CREATE STATEMENT

Create statement creates a table with the given column names. A column defined as Not Null are mandatory fields. A unique key is used to uniquely identify each record in an oracle table. There can be one and only one row with each unique key value.

```
SQL> create table student_language
  2  (rollno varchar2(3),
  3  language varchar2(10));
Table created.
SQL>  create table student_language
  2   (rollno varchar2(3) not null,
  3  language varchar2(10));
Table created.
```

SQL> create table student_language

2 (rollno varchar2(3),

3 language varchar2(10),

4 constraint unq_roll unique(rollno));

Table created.

DROP STATEMENT

Drops a table from the database.

SQL> drop table student_language;

Table dropped.

INSERT STATEMENT

Now when the tables are created, insert statement is used to populate the table. Insert statement adds a row of data to the table.

SQL> insert into student_detail

2 (rollno, name, age)

3 values

4 (‘008’ , ‘tarun’, 17);

1 row created.

SELECT STATEMENT

This is the most commonly used command; it is used to retrieve data from the database.

SQL> select * from student_detail;

ROL	NAME	AGE
001	achyut	17
002	charu	18
003	kapil	17
004	neeraj	17
005	ravi	16
006	shweta	17
007	tarvinder	18

7 rows selected.

SQL> select rollno, marks from student_rank;

ROL	MARKS
C01	225.5
C02	174.5
C03	263.5
C04	221.5
C05	178
C06	218.5
C07	235

7 rows selected.

SQL> select rollno, marks, marks/3

2 from student_rank;

ROL	MARKS	MARKS/3
001	225.5	75.166667
002	174.5	58.166667
003	263.5	87.833333
004	221.5	73.833333
005	178	59.333333
006	218.5	72.833333
007	235	78.333333

7 rows selected.

SQL> select rollno, marks, marks/3 average

2 from student_rank

3 ;

ROL	MARKS	AVERAGE
C01	225.5	75.166667
C02	174.5	58.166667
C03	263.5	87.833333
C04	221.5	73.833333
C05	178	59.333333
C06	218.5	72.833333
C07	235	78.333333

7 rows selected.

SQL> select rollno, marks, marks/3 average

2 from student_rank

3 ;

ROL	MARKS	AVERAGE
C01	225.5	75.166667
C02	174.5	58.166667
C03	263.5	87.833333
C04	221.5	73.833333
C05	178	59.333333
C06	218.5	72.833333
C07	235	78.333333

7 rows selected.

SQL> select distinct class

2 from student_class;

CLASS

arts
commerce
science

SQL> select * from student_class

2 where rollno='006';

ROL CLASS

006 science

SQL> select rollno, rank from student_rank

2 where marks>210;

ROL	RAN
001	3
003	1
004	4
006	5
007	2

SQL> select rollno, rank from student_rank

2 where marks<2*(total/3);

ROL	RAN
002	7
005	6

SQL> select rollno, marks, marks/3 average

2 from student_rank

3 ;

ROL	MARKS	AVERAGE
001	225.5	75.166667
002	174.5	58.166667
003	263.5	87.833333
004	221.5	73.833333
005	178	59.333333
006	218.5	72.833333
007	235	78.333333

7 rows selected.

ORACLE FUNCTIONS

Functions are use to manipulate data (in tables) and return the result. Functions are used with the arguments, i.e. data items or user defined variable and constant, on which the function acts. They can be either number or character functions.

Single row character functions accept character data as input and can return character values.

```
SQL> select upper(name), lower('Student')
  2  from student_detail;

UPPER(NAME)         LOWER
ACHYUT              student
CHARU               student
KAPIL               student
NEERAJ              student
RAVI                student
SHWETA              student
TARVINDER           student

7 rows selected.

SQL> select initcap(name)
  2  from student_detail;

INITCAP(NAME)
Achyut
Charu
Kapil
Neeraj
Ravi
Shweta
Tarvinder

7 rows selected.

SQL> select lpad(rollno,10,'*'), lpad(mathematics,10,'&')
  2  from student_marks;

LPAD(ROLLNO)        LPAD(MATHE)
*******001          &&&&&&&&80
*******002          &&&&&&&&63
*******003          &&&&&&98.5
*******004          &&&&&&&&54
*******005          &&&&&&&&40
*******006          &&&&&&78.5
```

*******007 &&&&&&&&88

7 rows selected.

SQL> select rpad(rollno,10,’*’), rpad(mathematics,10,’&’)

  2 from student_marks;

RPAD(ROLLNO)	RPAD(MATHE)
001*******	80&&&&&&&&
002*******	63&&&&&&&&
003*******	98.5&&&&&&
004*******	54&&&&&&&&
005*******	40&&&&&&&&
006*******	78.5&&&&&&
007*******	88&&&&&&&&

7 rows selected.

SQL> select substr(‘oracle’,3,3), substr(name, 2, 3)

  2   from student_detail;

SUB	SUB
acl	chy
acl	har
acl	api
acl	eer
acl	avi
acl	hwe
acl	arv

7 rows selected.

SQL> select rollno, name, instr(name, ‘a’)

  2   from student_detail;

ROL NAME	INSTR(NAME,’A’)
001 achyut	1
002 charu	3
003 kapil	2
004 neeraj	5
005 ravi	2
006 shweta	6

007 tarvinder 2

7 rows selected.

SQL> select name, ltrim(name, ‘a’), ltrim(name, ‘r’)

2 from student_detail;

NAME	LTRIM(NAME	LTRIM(NAME
achyut	achyut	achyut
charu	charu	charu
kapil	kapil	kapil
neeraj	neeraj	neeraj
ravi	ravi	ravi
shweta	shweta	shweta
tarvinder	tarvinder	tarvinder

7 rows selected.

SQL> select name, rtrim(name, ‘a’), rtrim(name, ‘r’)

2 from student_detail;

NAME	RTRIM(NAME	RTRIM(NAME
achyut	achyut	achyut
charu	charu	charu
kapil	kapil	kapil
neeraj	neeraj	neeraj
ravi	ravi	ravi
shweta	shwet	shweta
tarvinder	tarvinder	tarvinde

7 rows selected.

SQL> select rollno, name, soundex(name), age

2 from student_detail;

ROL NAME	SOUN	AGE
001 achyut	A230	17
002 charu	C600	18
003 kapil	K140	17
004 neeraj	N620	17
005 ravi	R100	16
006 shweta	S300	17
007 tarvinder	T615	18

7 rows selected

SQL> select length(‘Oracle Company’), length(rollno), length(physics)

2 from student_marks;

LENGTH(‘ORACLECOMPANY’)	LENGTH(ROLLNO)	LENGTH(PHYSICS)
14	3	2
14	3	2
14	3	
14	3	
14	3	
14	3	2
14	3	

7 rows selected.

SQL> select rollno, translate(rollno, ‘0’, ‘$’)

2 from student_detail;

ROL	TRA
001	$$1
002	$$2
003	$$3
004	$$4
005	$$5
006	$$6
007	$$7

7 rows selected.

SQL> select rollno, class, replace(class, ‘arts’, ‘home science’)

2 from student_class;

ROL	CLASS	REPLACE (CLASS,'ARTS','HOMESCIENCE')
001	science	science
002	science	science
003	arts	home science
004	arts	home science
005	arts	home science
006	science	science
007	commerce	commerce

7 rows selected.

SQL> select avg(marks) from student_rank;

AVG(MARKS)

216.64286

SQL> select count(*) from student_class

2 where class=’science’;

COUNT(*)

3

SQL> select greatest(1200, 4500), greatest(total, marks)

2 from student_rank where rollno=’005';

GREATEST(1200,4500)	GREATEST(TOTAL, MARKS)
4500	300

SQL> select least(1200, 4500), least(total, marks)

2 from student_rank where rollno=’007';

LEAST(1200,4500)	LEAST(TOTAL,MARKS)
1200	235

SQL> select * from student_detail

2 where age=to_number('17');

ROL	NAME	AGE
001	achyut	17
003	kapil	17
004	neeraj	17
006	shweta	17

SQL> select min(marks) from student_rank;

MIN(MARKS)

174.5

SQL> select rollno, marks, total, mod(marks, total),

2 mod(total, marks), mod(100,40)

3 from student_rank where rollno='003';

ROL	MARKS	TOTAL	MOD (Marks, Total)	MOD (Total, Marks)	MOD(100,40)
003	263.5	300	263.5	36.5	20

SQL> select rollno, mathematics+english+ nvl(physics, 0)

2 +nvl(accountancy, 0)+nvl(history, 0) total_ marks

3 from student_marks;

ROL	TOTAL_MARKS
001	225.5
002	174.5
003	263.5
004	224.5
005	178
006	218.5
007	235

7 rows selected.

SQL> select marks-total, sign(marks-total)

2 from student_rank;

MARKS-TOTAL	SIGN(MARKS-TOTAL)
-74.5	-1
125.5	1
-36.5	-1
-78.5	-1
122	1
81.5	1
65	1

7 rows selected.

SQL> select rollno, marks, total, abs(marks-total), 2 abs(total-marks), abs(-45), abs(45)

3 from student_rank where rollno=’005';

ROL	MARKS	TOTAL	ABS (Marks-Total)	ABS (Total-Marks)	ABS(-45)	ABS(45)
005	178	300	122	122	45	45

SQL> select rollno, marks, rank from student_rank

2 where marks = (select min(marks) from student_rank);

ROL	MARKS	RAN
02	174.5	7

SQL> select rollno, vsize(rollno), class, vsize(rollno)

2 from student_class;

ROL	VSIZE (ROLLNO)	CLASS	VSIZE (ROLLNO)
001	3	science	3
002	3	science	3
003	3	arts	3
004	3	arts	3
005	3	arts	3
006	3	science	3
007	3	commerce	3

7 rows selected.

SQL> select rollno, marks, sqrt(marks) from student_rank;

ROL	MARKS	SQRT(MARKS)
001	225.5	15.016657
002	174.5	13.209845
003	263.5	16.232683
004	221.5	14.882876
005	178	13.341664
006	218.5	14.781745
007	235	15.32971

7 rows selected.

SQL> select rollno, mathematics+english+ nvl(physics, 0)

2 +nvl(accountancy, 0)+nvl(history, 0) total_marks

3 from student_marks;

ROL	TOTAL MARKS
001	225.5
002	174.5
003	263.5
004	224.5
005	178
006	218.5
007	235

7 rows selected.

JOIN CONDITION

A join is used when a SQL query requires data from more than one table on database.

Rows in one table may be joined to rows in another according to common values existing in corresponding columns. There are two main types of join condition : Equi-join and Non-equi-join.

```
SQL> select sc.class, avg(sr.marks)
  2  from student_class sc, student_rank sr
  3  where sc.rollno = sr.rollno
  4   group by sc.class;
```

CLASS	AVG(SR.MARKS)
arts	221
commerce	235
science	205.16667

```
SQL> select student_detail.rollno, name, marks, rank
  2  from student_detail, student_rank
  3  where student_detail.rollno = student_ rank.rollno;
```

ROL	NAME	MARKS	RAN
001	achyut	225.5	3
002	charu	174.5	7
003	kapil	263.5	1
004	manoj	221.5	4
005	ravi	178	6
006	shweta	218.5	5
007	tarvinder	235	2

7 rows selected.

```
SQL> select sc.rollno, name, age, class
  2  from student_detail sd, student_class sc
  3  where sd.rollno = sc.rollno
  4  order by class;
```

ROL	NAME	AGE	CLASS
003	kapil	17	arts
004	neeraj	17	arts
005	ravi	16	arts
007	tarvinder	18	commerce
001	achyut	17	science
002	charu	18	science
006	shweta	17	science

7 rows selected

```
SQL>  select sd.rollno, name, marks, rank
  2  from student_detail sd, student_rank sr
  3  where sd.rollno = sr.rollno
  4  and sr.marks between 190 and 230;
```

ROL	NAME	MARKS	RAN
001	achyut	226.5	3
004	neena	221.5	4
006	shweta	216.5	5

SET OPERATORS

UNION, INTERSECT and MINUS are useful in constructing queries that refer to different tables. They combine the results of two or more select statements into one result. A query may therefore consist of two or more SQL statements linked by one or more set operators. Set operators are often called vertical joins, because the join is not according to rows between two tables, but columns.

```
SQL>  select class from student_class
  2  where class = 'science'
  3  union
  4  select class from student_class
  5  where class = 'commerce';
CLASS
commerce
science
SQL> select rollno from student_detail
  2  intersect
  3  select rollno from student_class;
ROL
001
002
003
004
005
006
007
7 rows selected.
SQL> select rollno from student_detail
  2  minus
  3  select rollno from student_class;
no rows selected
```

THE 'ORDER BY' CLAUSE

Normally the order of rows returned in a query result is undefined. The ORDER BY must always be the last clause in the SELECT statement.

```
SQL> select * from student_rank
  2  order by rank;
```

ROL	MARKS	TOTAL	RAN
003	263.5	300	1
007	235	300	2
001	225.5	300	3
004	221.5	300	4
006	210.5	300	5
005	178	300	6
002	174.5	300	7

7 rows selected.

```
SQL> select * from student_rank
  2  order by rank desc;
```

ROL	MARKS	TOTAL	RAN
002	174.5	300	7
005	178	300	6
006	210.5	300	5
004	221.5	300	4
001	225.5	300	3
007	235	300	2
003	263.5	300	1

7 rows selected.

SQL OPERATORS AND NEGATING EXPRESSIONS

There are four SQL operators and it’s equivalent negating operators which operate with all data types,

BETWEEN..AND…
IN(list)
LIKE
IS NULL
NOT BETWEEN
NOT IN
NOT LIKE
IS NOT NULL

```
SQL> select rollno, mathematics, english, history
  2  from student_marks
  3  where history is null;
```

ROL	MATHEMATICS	ENGLISH	HISTORY
001	80	67.5	
002	63	55.5	
003	98.5	76	
004	54	72	
005	40	81.5	
006	78.5	73	

6 rows selected.

```
SQL> select rollno, mathematics, english, history
  2   from student_marks
  3   where history is not null;
```

ROL	MATHEMATICS	ENGLISH	HISTORY
007	88	69	78

```
SQL> select rollno, class from student_class
  2  where rollno between 002 and 007
  3  and
  4  class = 'science';
```

ROL	CLASS
002	science
006	science

```
SQL> select rollno, class from student_class
  2  where rollno between 002 and 007
  3  or
  4   class = 'science';
```

ROL	CLASS
001	science
002	science
003	arts
004	arts
005	arts
006	science
007	commerce

7 rows selected.

```
SQL> select rollno, name, age
  2  from student_detail
  3  where age>=17
  4  and rollno between 002 and 006
  5  or name = 'tarvinder';
```

ROL	NAME	AGE
002	dhanu	18
003	kapil	17
004	neeraj	17
006	shweta	17
007	tarvinder	18

SQL> select * from student_rank

2 where marks between 170 and 210;

ROL	MARKS	TOTAL	RAN
002	174.5	300	7
005	178	300	6

SQL> select * from student_detail

2 where rollno in (002, 004, 005);

ROL	NAME	AGE
002	dhanu	18
004	neeraj	17
005	ravi	16

SQL> select * from student_detail

2 where name like '%t%';

ROL	NAME	AGE
001	achyut	17
006	shweta	17
007	tarvinder	18

SQL> select * from student_detail

2 where name like '____';

ROL	NAME	AGE
005	ravi	16

SQL> select * from student_rank

2 where marks not between 170 and 210;

ROL	MARKS	TOTAL	RAN
001	225.5	300	3
003	263.5	300	1
004	221.5	300	4
006	218.5	300	5
007	235	300	2

STARTING A COMMAND FILE CONTAINING SUBSTITUTION VARIABLES

Suppose you want a series of reports to list the employees with various jobs, use a substitution variable to obtain these several reports from a single SELECT statement.

SQL> define avr = 'marks/3'

SQL> select * from student_rank

```
  2  order by &avr;
old   2: order by &avr
new   2: order by marks/3
```

ROL	MARKS	TOTAL	RAN
002	174.5	300	7
005	178	300	6
006	218.5	300	5
004	221.5	300	4
001	225.5	300	3
007	235	300	2
003	263.5	300	1

7 rows selected.

```
SQL> select rollno, mathematics, english
  2  from student_marks
  3  where rollno = &Roll_NO;
Enter value for roll_no: 003
old   3: where rollno = &Roll_NO
new   3: where rollno = 003
```

ROL	MATHEMATICS	ENGLISH
003	98.5	76

```
SQL> select rollno, &arithmetic_expression
  2  from student_rank;
Enter value for arithmetic_expression: marks/3
old   1: select rollno, &arithmetic_expression
new   1: select rollno, marks/3
```

ROL	MARKS/3
001	75.166667
002	58.166667
003	87.833333
004	73.833333
005	59.333333
006	72.833333
007	78.333333

7 rows selected.

DATE FUNCTIONS

Date functions operate on Oracle dates. These functions operate on the dates and times taken from the system.

```
SQL> select sysdate, sysdate+7, sysdate-7
```

2 from sys.dual;

SYSDATE	SYSDATE+7	SYSDATE-7
06-OCT-99	13-OCT-99	29-SEP-99

SQL> select sysdate from sys.dual;

SYSDATE

06-OCT-99

SQL> select sysdate, next_day(sysdate, ‘friday’)

2 from sys.dual;

SYSDATE NEXT_DAY(

06-OCT-99 08-OCT-99

SQL> select sysdate, last_day(sysdate)

2 from sys.dual;

SYSDATE LAST_DAY(

06-OCT-99 31-OCT-99

SQL> select sysdate, round(sysdate, ‘month’),

2 round(sysdate, ‘year’) from sys.dual;

SYSDATE	ROUND(SYS	ROUND(SYS
06-OCT-99	01-OCT-99	01-JAN-00

SQL> select sysdate, trunc(sysdate, ‘month’),

2 trunc(sysdate, ‘year’) from sys.dual;

SYSDATE	TRUNC(SYS	TRUNC(SYS
06-OCT-99	01-OCT-99	01-JAN-99

SQL> select sysdate, to_char(sysdate, ‘day, ddth month yyyy’)

2 from sys.dual;

SYSDATE	TO_CHAR(SYSDATE,'DAY,DDTHMONTHYYYY')
06-OCT-99	wednesday, 06th october 1999

SQL> select months_between(sysdate, sysdate+12)

2 from sys.dual;

MONTHS_BETWEEN(SYSDATE,SYSDATE+12)

-.3870968

SQL> select sysdate, add_months(sysdate, 7)

2 from sys.dual;

SYSDATE	ADD_MONTH
06 OCT 99	06 MAY 00

BREAK

Specifies where and how formatting will change in a report, such as suppressing display of duplicate values for a given column, skipping a line each time a given column value changes and printing computed figures each time a given column value changes.

SQL> break on class skip 1

SQL> select * from student_class;

ROL	CLASS
001	science
002	
003	arts
004	
005	
006	science
007	commerce
7 rows selected	

ALTER TABLE

Alter statement is uesd to bring a change in the table. We can modify the table or add into table any column or constraint.

SQL> alter table student_language

2 modify (language varchar2(15));

Table altered.

SQL> alter table student_language

2 add (duration number(2));

Table altered.

SQL> alter table student_language

2 drop constraint fr_roll;

Table altered.

DELETE STATEMENT

This statement is used to delete a row of data item from a table.

SQL> delete from student_detail

2 where name = ‘tarun’;

1 row deleted.

UPDATE STATEMENT

Update statementm is used to change the data values given in the table.

```
SQL> update student_marks
  2  set english = 72
  3  where rollno = '004';
1 row updated.
```

REVISION EXERCISES

1. Create a table having the following column names: ent_no, f_name, L_name, age, date_join, salary.
2. In the above table write statement to read data namewise, in a salary (Rs 4000-5000).
3. What is the difference between intersect and union.

Chapter 16: COMPUTERS AND COMMUNICATION

Communication is the need of the day and not having the basic knowledge of many communication systems (such as telephone etc) could easily imply to your being uneducated. The telephones, the radios and the televisions in our living rooms, the newspaper and of course the computer terminals are very reliable sources of information from any part of the world. The ships, the air crafts, the rockets, the satellites etc., rely on the communication systems for their successful operation. And thus, 'Communication 'can be said to be one of the major factors for the rapid modernization of the world.

In the most fundamental sense, communication involves implicitly the transmission of information from one point to another through a succession of processes. Information being sent is also referred to as 'Data'. This chapter basically deals with data transmission through computers and the communication channels involved in the process.

THE BASIC COMMUNICATION SYSTEM

There are three basic elements in every communication system; namely the transmitter, the channel and the receiver as shown in the figure.

The transmitter and the receiver are isolated from each other and it is the channel that connects them together. The transmitter transforms the message signal, produced by the source of information into a form suitable for transmission over the channel. As the signal progresses through the channel, noise and other distortions are added to it which corrupt the original signal. The receiver receives this corrupted signal and does the task of converting it back to the original signal and delivers it to the user destination. The noise and the other disturbances added depend upon the length of the channel.

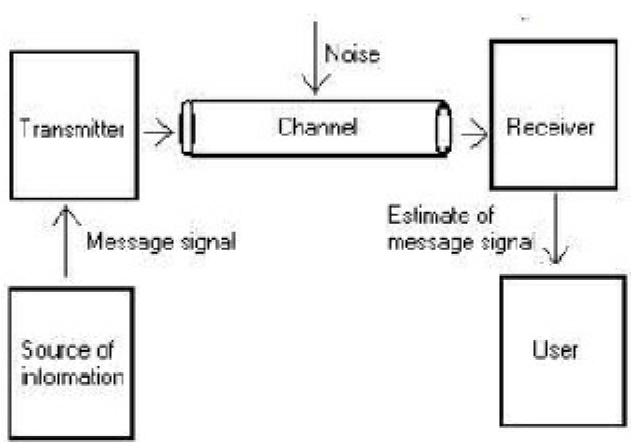


Figure 16.1: The Basic Communication System

DATA TRANSMISSION

As said earlier the information being delivered through a communication system is referred to as data. Data communication through computers provides an easy and inexpensive solution to the problem of accessing data at each and every terminal in a multi user system. Instead of having the same data in each and every computer, thereby utilizing a lot of memory space, all the data can be stored in the memory of one or a few computer systems which can then be accessed by the other terminals linked through direct cables. In the case of geographically dispersed systems, data communication provides the most economic way of data sharing with regular updates in the data being accurate in all the terminals at all times.

Form of data when being transmitted

Data when being transmitted can take one of the following forms.

1. Analog Form.
2. Digital Form.

We shall discuss each of these in detail.

Analog Data Signals

Analog data signals are in the form of continuous waveforms which may be periodic or non periodic.

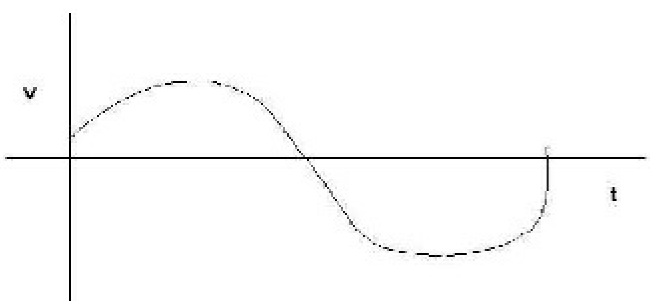


Figure 16.2: Non Periodic Analog Signal

There are three factors that govern the characteristics of an analog data signal –

1. Amplitude: The amplitude represents the value of the signal at a particular point of time.
2. Frequency: The frequency of a wave is the time that wave takes to complete one cycle. The frequency does not play a major role in the case of non periodic signals.
3. Phase: The phase of a signal is a relative concept. The phase refers to the relative state of the wave when the timing began. It is measured in degrees.

Digital Data Signals

Digital data signals can exist only in two states – ‘ON’ and ‘OFF’. The ‘ON’ state represents a ‘1’ and the ‘OFF’ state represents a ‘0’.

The telephone uses analog data signals to communicate, while the computer only accepts digital data signals. Hence, in case two computers wish to communicate using a telephone line, analog to digital and digital to analog conversion has to take place. This process is better known as modulation and demodulation (discussed later).

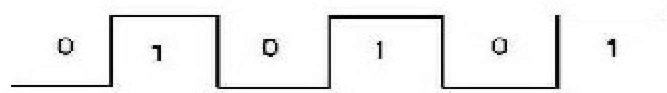


Figure 16.3: Digital Data Signal

ADC and DAC

Computer systems process data only in the form of binary numbers, i.e., a computer can only receive digital pulses. Hence an analog signal must be converted into a digital signal before being fed into the computer. Therefore, for communication to take place through a telephone line (analog signal format) the analog to digital and the digital to analog conversion is necessary. Analog to digital conversion can be carried out using an analog to digital converter (ADC) and the digital to analog conversion is carried out using a digital to analog converter (DAC).

Analog to Digital Converters

There are many methods by which Analog to Digital conversion is possible but we shall discuss only two of them in this book. They are:

Ramp Conversion

Ramp conversion although the cheapest of all is the slowest method of converting analog information to digital. It is used in digital voltmeters.

The input voltage to be measured is fed to the COMPARATOR. When the CONVERT signal is activated, the CONTROL resets the COUNTER and then supplies clock pulses to the counter, which outputs an analog voltage in response to its digital input. The output of the D/A converter is then fed to the comparator along with the input voltage with which it is compared. This process goes on until the D/A input exceeds the input voltage after which the COUNTER stops. The reading of the COUNTER represents the voltage of the input signal in terms of a binary number.

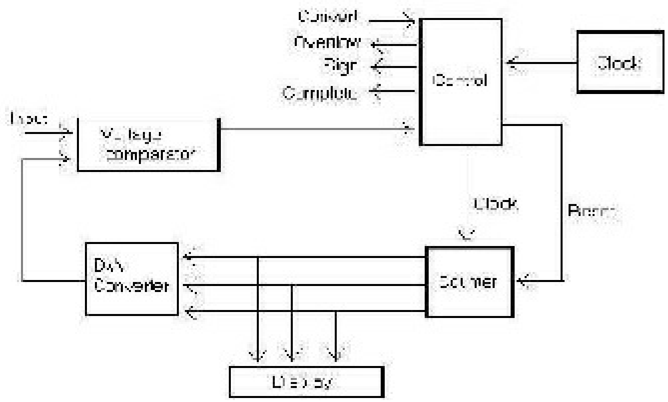


Figure 16.4: Ramp Conversion

The sign signal indicates the polarity of the output and the overflow signal indicates the case where the input signal exceeds the highest possible voltage of the D/A converter.

Successive Approximation

The successive approximation method is costlier then the ramp method but it is very fast. The block diagram is as shown in the Figure 16.5 below.

Suppose we need to convert 22.4 v into a five bit binary number using a maximum reference of 32V. The REGISTER is first set to 0 & then a 1 is placed is its MSB. This is fed to the COMPARATOR after being converted by the D/A converter. If it is greater than the INPUT the bit (i.e. MSB) is set to 0 . If the output of the D/A is less than the INPUT, the 1 is retained. This process carries on until an approximate value of the INPUT is achieved in terms of a binary number.

If exact precision in required this process should be allowed to convert until 22.4V is achieved.

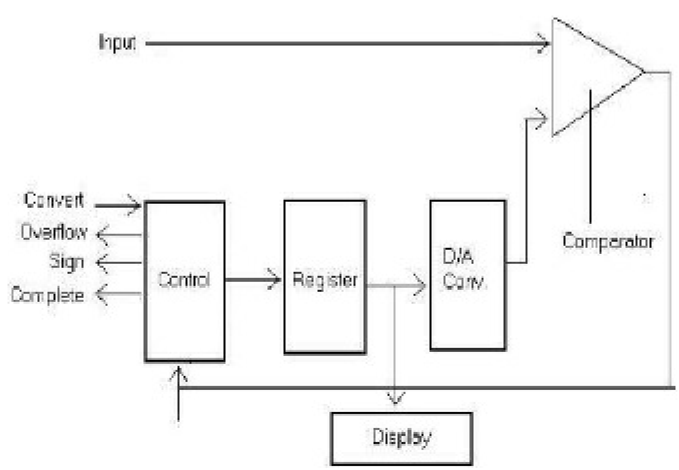


Figure 16.5: Successive Approximation

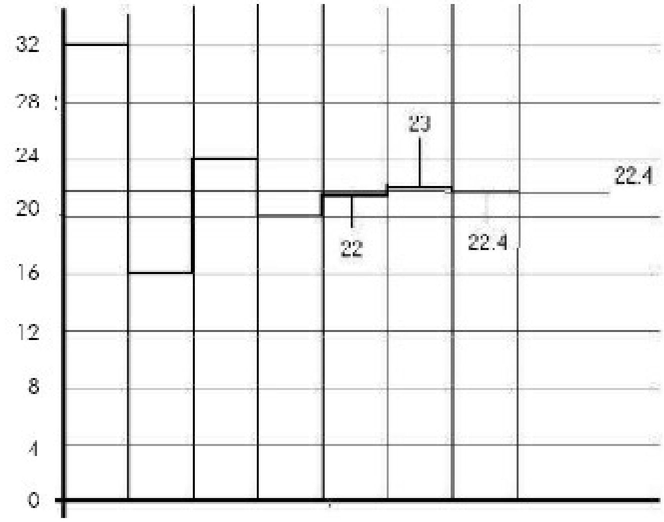


Figure 16.6: Graph for Successive Approximation

Digital to Analog Converters

As the name suggests a DAC converts a digital signal to an analog signal. Each digital bit is treated in a weighted manner, i.e., the MSB is given the highest weighted and so on. We shall try to explain this concept with the help of a weighted resistor network.

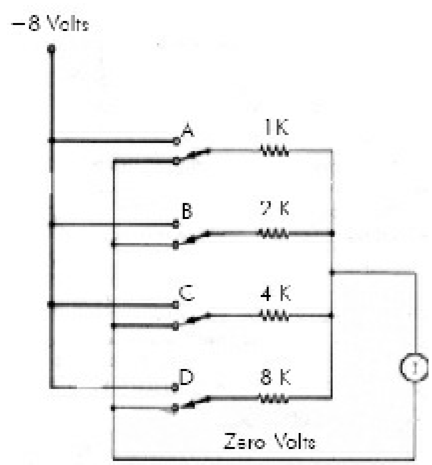


Figure 16.7: Weighted Resistor Network

The most significant bit A supplies the maximum current (due to least resistance).

We have given a table of the different combinations of the switches A,B,C,D and of the output these combinations would produce.

A	B	C	D	OUTPUT (A+B+C+D)
0	0	0	0	0
0	0	0	1*1	1
0	0	1*2	0	2
0	0	1*2	1*1	3
0	1*4	0	0	4
0	1*4	0	1*1	5
0	1*4	1*2	0	6
0	1*4	1*2	1*1	7
1*8	0	0	0	8
1*8	0	0	1*1	9
1*8	0	1*2	0	10
1*8	0	1*2	1*1	11
1*8	1*4	0	0	12
1*8	1*4	0	1*1	13
1*8	1*4	1*2	0	14
1*8	1*4	1*2	1*1	15

Data Transmission Technique

From a general communication system let us turn our attention to something more specific a telecommunication system. A telecommunication system consists of two or more computers exchanging information over telephone lines. Each computer in the system must be connected to a modem, which in turn is connected to the phone line.

The Modem

The modem's basic role is to convert analog signals to digital signals & vice-versa. When digital information is sent from the computer to the telephone line, the modem converts it into analog. This conversion process is called MODULATION. When information is sent from the telephone line to the computer, the opposite process DEMODULATION occurs, i.e., analog data is converted to digital. Infact, the modem receives its name from MODulation/DEModulation.

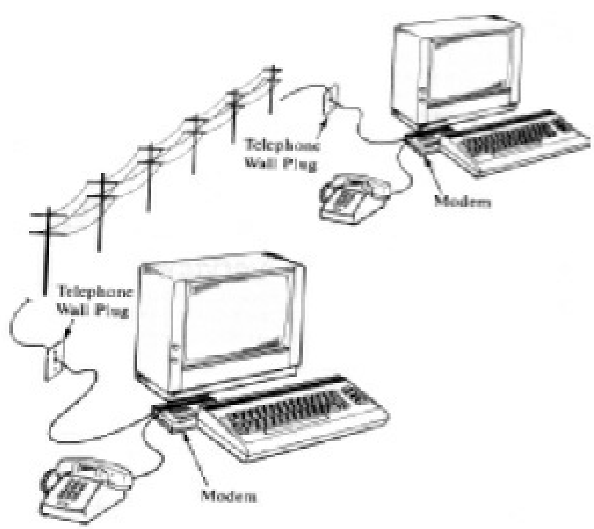


Figure 16.8: Telecommunication Network

Generally speaking there are two types of modems –

1. Acoustic Coupler Modem

These modems do not require a direct connection to the computer. Instead the telephone headset is inserted in to the modem's rubber cups. The figure is self explanatory as to the modems functioning.

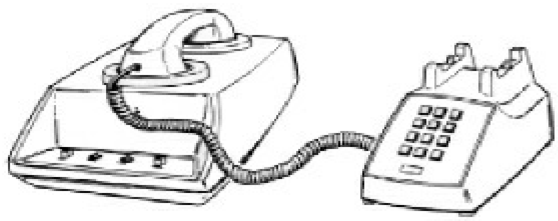


Figure 16.9: Acoustic Coupler Modem

2. Direct Connect Modem

A direct connect modem makes a direct connection between the computer and the telephone line. Direct connect modems are of two types –

a) External direct connect modems: External direct connect modems are externally connected to the computer and usually have a separate power supply. The external modem is also sometimes referred to as the "intelligent modem" because of its ability to automatically dial, redial and disconnect.

b) Internal direct connect modems: An internal direct connect modem is a printed circuit board which is plugged into one of the slots provided in the computers motherboard.

Direct connect modems are superior to acoustic couplers for almost every telecomputing application. They are usually easier to use, less expensive and more reliable.

The Modem Lights

The indicator lights on the front of an external modem tells you what's happening during your communications session. The exact locations of the lights and the order in which they appear varies from modem to modem. Modem lights are usually labeled with two character abbreviations. Some of the common abbreviations are listed below.

HS – High Speed. The blinking high speed light indicates that your modem is currently operating at its highest available transmission rate.

AA – Auto Answer. The auto answer light indicates that your modem will automatically answer any incoming calls. This feature allows message access to your system while it is left unattended.

CD – Carrier Detect. The carrier detect light goes on whenever your modem detects a carrier signal, which means it has successfully made a connection with a remote computer. The light should go out only when one of the computers hangs up its line and the carrier signal is dropped.

OH – Off Hook**.** The off hook light goes on whenever your modem takes control of the phone line. This is equivalent to taking your telephone receiver off the hook.

RD – Receive Data. The Receive data light flickers each time the modem transfers data to your computer. This happens whenever you are receiving data from the remote PC.

SD – Send Data**.** The send data light flashes each time your computer transfers data to the modem, whenever you are sending data to the remote computer.

TR – Terminal Ready. The terminal ready light goes on when the modem detects a DTR signal from your communication software. This signal informs your modem that a communication program is loaded and is ready to run.

MR – Modem Ready. The Modem Ready light lets you know that your modem is turned on and ready to operate.

The indicator lights are particularly useful when you are facing communication problems.

METHODS OF TRANSMISSION

Data can be transmitted in either of the following two ways:

1. Asynchronous transmission
2. Synchronous transmission

Asynchronous Transmission

Asynchronous communication is the basic method of computer to computer information exchange. It simply means that one character is transmitted at a time.

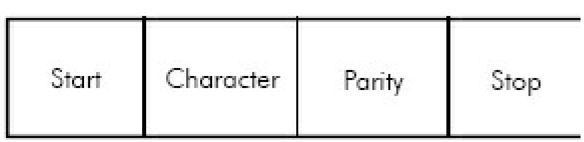


Figure 16.10: Asynchronous Transmission

Shown above in the figure is the character along with some bits surrounding it that mark the beginning and the ending of the character. Note that the character here is in the form of bits (0 and 1). This type of transmission is obviously of very low speed since only one character is transmitted at a time.

Because of its nature, asynchronous transmission is often referred to as start stop transmission. Since only one character has to be transmitted at a time the probability of error occurring in the overall transmission of the data string is very low and almost negligible.

Synchronous Transmission

Synchronous transmission on the other hand involves blocking a group of characters surrounded by synchronization characters. Once the start bit is detected by the receiver it starts receiving the data string (in the form of bits), until the ending bit is encountered. A predetermined number of characters can also be a criteria for the receiver to stop receiving.

Synchronous transmission is obviously much more faster than asynchronous transmission as a number of characters are transmitted in one go. Synchronous transmission ensures efficient utilization of the transmission line.

But this type of transmission requires that a buffer storage be provided at both ends (receiving as well as transmitting) for assembling and disassembling the data (in the form of blocks) being transmitted. This is also need for accurately synchronized clock at both ends. It is because of this that the synchronous transmission equipment costs more.

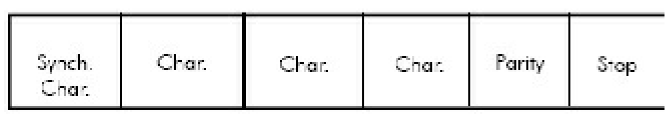


Figure 16.11: Synchronous Transmission
The Synchronous Character Not Only Indicates the Start Bit
But Also Infoms about the Number of Character

Shown above is a block diagram depicting the flow of information, when synchronously transmitted. The parity is a single byte used for error detection.

ERROR DETECTION

Many methods for error detection are available but the simplest technique of them all is that of adding an extra bit, known as a parity bit, to each character or block of characters when being transmitted. The receiver checks for the parity bit and in case an incorrect parity bit is detected the receiver can inform the transmitter to retransmit the character or block of characters as the case may be.

Let us explain this by an example:

Suppose 110101 is to be transmitted. Let us assume that the system is working in odd parity. This means that the number of 1 bits in the entire word is odd. Now 110101 has an even number of one’s (= 4) , therefore a parity bit of 1 would be included to make the total no. of 1’s an odd no.

Similarly, a parity bit of 0 would be required for 110111 to maintain an odd no. of 1’s.

COMMUNICATION PARAMETERS

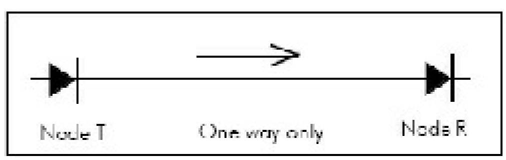
The basic communication parameters are :-

1. Word length: Word length refers to the number of bits that make up a character. Typical word lengths are 7 or 8 bits per character. If your system is set to read 7 bits per character and the other computer sends 8 bits per character, communication will be very unreliable.
2. Baud rate: Baud rate is the speed at which data transfer occurs and is measured in bits per second.
3. Parity: Parity as defined earlier is a single bit transmitted alongwith the data, for error detection.
4. Start and Stop bits: As defined earlier Start and Stop bits mark the beginning and end of data respectively.

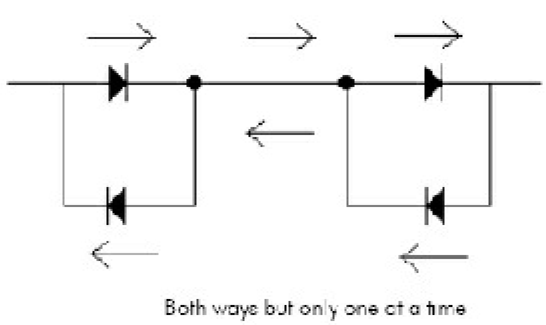
MODES OF TRANSMISSION

Data can be transmitted in one of the following three modes-

1. Simplex mode: In simplex mode, data is transmitted unidirectionally. That is data can only go in one direction and hence only one data path is required. This mode can be represented by using semiconductor diodes as follows:-



2. Half-duplex mode: In Half Dulpex mode, data can be sent in both directions but one by one. There is a single path along which data transfer takes place but only in one direction at a time.



Shown above is a representation in terms of semiconductor diodes.

3. Full-duplex mode: In full duplex mode, data transfer takes place in both directions simultaneously. It is obvious that the full duplex mode is faster than the half duplex mode as both directions are accessible simultaneously.

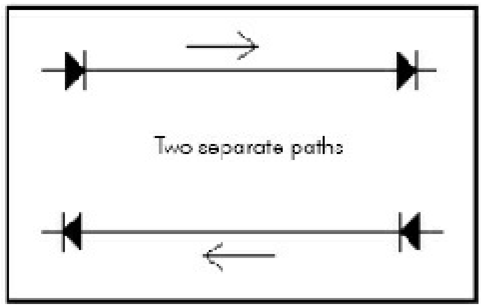


Figure 16.14: Full Duplex Mode

COMMUNICATION CHANNELS

Communication channels can be classified according to their-

1. Bandwidths
2. Transmission Media

Communication Channel Bandwidths

The bandwidth of a communication channel decides the data volume as well as the data transmission rate. Three bandwidths may be used-

1. Narrow Band

   The Narrow Band channel handles low volumes of data. The transmission rate in this band is also low; approximately from 40 to 300 baud. Telegraph lines work under this bandwidth.

2. Voice Band

   The Voice Band channel handles moderate volumes of data. The transmission rates vary from 300 to 9600 baud. Telephone lines work under this bandwidth. Another example is that of a CRT.

3. Broad Band

   Broad Band channels handle very large volumes of data and also have a very high transmission rate. Satellite communication is an example of broad band channels.

The Transmission Media

Transmission media refers to the medium through which data transmission from the transmitter to the receiver takes place.

The various transmission media are as follows:

1. Fiber Optics
2. Microwave
3. Satellite links
4. Wire Cables

We shall discuss each of these in detail:

Fiber Optics

Fiber optics cables are very thin tubes made of glass or plastic (mostly silica). The diameter of a glass fiber is very small. Fiber optic cables transmit light pulses from the light source to the detector. Presence of light indicates a 1 bit and the absence of light indicates a zero bit. Such a system is known as an optical transmission system.

Transmission of data through fiber optic cables is very fast and most importantly is unaffected by electrical interference's. As compared to a copper telephone line data transmission through a fiber optic cable is 75,600 times faster.

Fiber optic cables, as should be obvious, are much more expensive as compared to copper wires but another advantage they have is that of providing very high bandwidths.

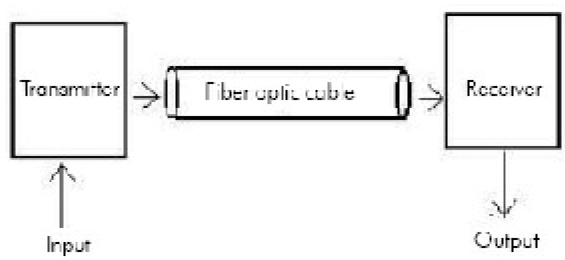


Figure 16.15: Data Transmission Using Fiber Optic Cable

A repeater is required in fiber optic cables after a certain distances to boost the signal power.

Microwave

The data in analog from is concentrated into a beam having a frequency above 100 Mhz(Megahertz) and is transmitted in a straight line to a satellite. The communication satellite redirects the signal to some other point on earth. The receiving end has a microwave tower which receives the redirected signal.

Microwave signals travel in straight lines. They can't pass through buildings. Microwave signals are weather and frequency dependent. Hence the atmospheric topology of the region has to be taken into account while transmitting the signal.

Data transmission using microwave signals is much more expensive due to the cost of satellites but the error rate is much lower than that of fiber optics.

Satellite Links

One form of communication through satellite is by using microwave signals. However microwave signals can also be transmitted without the satellite, i.e. for short distance communication the microwave towers can directly receive the signal.

Another form of communication through satellites is by using radio and TV waves, which are generally used for broadcast purposes. Unlike microwaves the radio waves can travel long distances and can go through buildings. Radio waves travel in all directions from the source they emerge out. Radio waves are frequency dependent.

Wire Cables

Wire cables have slower speeds but are usually cheaper. There are many ways of communicating through wire cables but some of the more common ones are detailed in this book.

Twisted pair

A twisted pair consists of two insulated copper wires twisted together in a helical form. The twisting of the two wires prevents electromagnetic interference and radiations. The bandwidth depends on the thickness of the wire and the distance it covers.

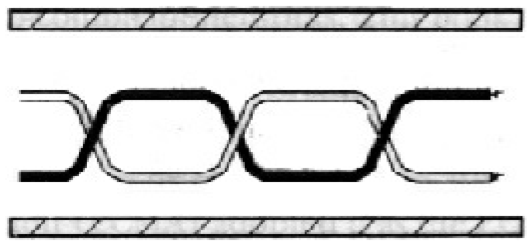


Figure 16.15: Twisted Pair Cable

Twisted pair cables provide a speed of few Mbps (Mega bits per second) which is quiet low as compared to that of fiber optic cables. As mentioned earlier a fiber optic cable is 75,600 times faster than a telephone cable (which is a twisted pair cable).

Twisted pair cables are low in cost as compared to fiber optics and easily available as well hence, twisted pair cables are more commonly used than fiber optic cables.

Twisted pair cables may either be shielded or unshielded. Shielded cables surround the center conductors with a jacket of fine, braided wires. Unshielded cables are less expensive and are more commonly used but they are more prone to electromagnetic interference than the shielded pair cables.

Shielded pair cables transfer data at a higher rate than the unshielded cable.

Coaxial Cables

Coaxial cables can transmit data even at very high frequencies and hence they have much higher rate of data transmission than the twisted pair cables. A coaxial cable consists of copper wire surrounded by an insulation and over the insulation a copper wire mesh is wrapped. This forms an electric shield around the main copper wire and reduces the electromagnetic interference.

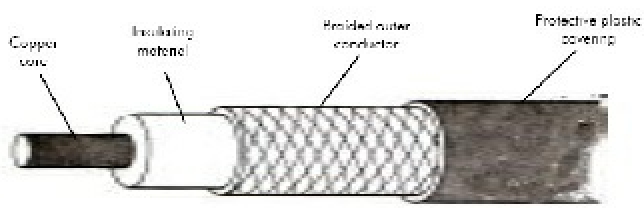


Figure 16.16: Coaxial Cable

The central copper wire carries the data while the braided outer conductor prevents the electrical disturbances. You may have seen the use of a coaxial cable in your cable TV network.

Coaxial cables are of two types

1. Baseband Coaxial Cable

Baseband Coaxial cables are used for digital data transmission. Therefore, baseband cables are usually employed for LANs.

2. Broadband Coaxial Cable

Broadband coaxial cables can work at frequencies as high as 450 MHz. Due to this they can transit many simultaneous signals using different frequencies. The data carried in these cables is essentially analog in nature.

Data transmission through these coaxial cables is very fast and is of the order of giga bits per second. However broadband signals require analog amplifiers after certain distances to strengthen the signal.

REVISION EXERCISES

1. Define Asynchronous and synchronous transmission of data? What are the merits and demerits of each over the other? Which method is better suited when cost is not a factor?
2. What are the advantages and disadvantages of a broad band channel over a narrow band channel?
3. What function does the copper wire mesh perform in a coaxial cable-
   i. Adds to the aesthetics of the wire.
   ii. Reduces electromagnetic interference.
   iii. Provides a better grip.
   iv. Carries the data.
4. Which of the following transmission media can be used in an optical transmission system
   i. Fiber optic cables.
   ii. Coaxial cables.
   iii. Twisted pair cables.
   iv. Microwaves.
5. Differentiate between shielded and unshielded twisted pair cables listing down the merits and demerits of each over the other?
6. What are the four basic communication parameters? Explain.
7. What is a parity bit?
8. Explain how a parity bit is used for error detection?
9. The HS light of the external modem indicates-
   i. Highest speed.
   ii. Hot sun.
   iii. Hits per second.
10. Differentiate between base band and broad band coaxial signals listing the merits and demerits of each over the other?
11. In a Communication system the unwanted disturbances are referred to as:

i. Music.

ii. Noise

iii. Speech.

iv. Radiation.

12. Which of the following statements is correct:

a. Fiber optic cables transmit light signals from the source to the detector.

b. In the half duplex mode data transmission can take place in both the directions simultaneously.

c. The auto answer light indicates that your modem will automatically answer any incoming calls.

d. The data transmission rate in the narrow band channel is very high; of the order of 40 to 300 baud.

e. Microwave signals travel only in straight lines.

f. The modem derives its name from the modulation demodulation process it performs.

Chapter 17: COMPUTER NETWORKS

A network can be defined as the interconnection of two or more systems. The minimum number of systems required to make a network is two.
Computer systems connected in a network can exchange information between themselves and share the use of hardware devices connected such as the printer etc.

A system with one main controlling unit known as the master and many slave terminals is not a network.

Computer networks are of three types:

1. Local area networks (LAN)
2. Metropolitan area networks (MAN)
3. Wide area networks (WAN)

We shall discuss each of these in detail.

LOCAL AREA NETWORKS (LAN)

Networks that connect computers lying within a small distance (such as a room, or within a building) from each other are called local area networks (or LANs).

Local area networks normally use coaxial cables to connect the computers together. Two or more computers connected together can share, besides data, their peripherals such as printers, modems etc. This cuts down a lot on the hardware equipment cost.

Besides coaxial cables, a plug-in card is also required for each computer. The coaxial cables connect the plug-in cards of the computers to form a network. A special software is also required for the network to operate.

All local area networks transfer data in digital form at a high speed and have a low implementation cost.

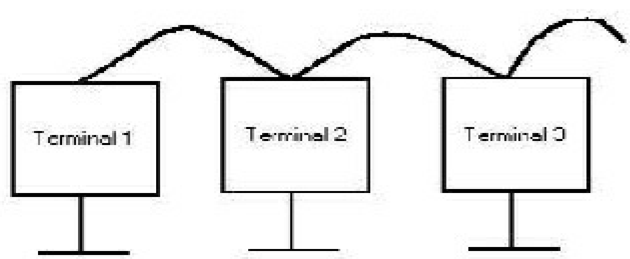


Figure 17.1: Local Area Network

Some applications performed by a LAN are as follows:

1. File transfer and access
2. Accessing the internet

3. Providing Management Information System.

METROPOLITAN AREA NETWORKS (MAN)

A metropolitan area network uses the distributed queue dual bus. The metropolitan area network is larger than a LAN and it may cover areas as large as a city. The distributed queue dual bus system consists of two buses connected to all the computers.

The Figure below depicts the two buses connecting three nodes.

The dual bus helps the transmission of data in both directions simultaneously. Data going up uses bus A and data going down uses Bus B.

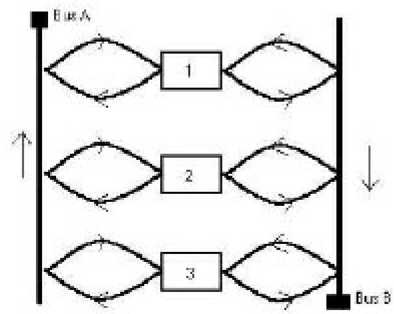


Figure 17.2: Metropolitan Area Network

Suppose information has to be passed from terminal 3 to 1, it will use Bus A and if a reply has to be sent back (from 1 to 3) it will use Bus B.

WIDE AREA NETWORKS (WAN)

A wide area network connects computers which are very remotely placed. It may connect across the countries or continents or the entire globe. Wide Area Networks are also referred to as Long Haul Networks (LHNs).

Wide area networks can either be point to point type or broadcast type. In a point to point type network, the source and the destination machines are connected to each other via several intermediate routers. A point to point type network may be separated into two parts– the hosts and the subnet. The machines between which communication is to be established are called hosts. The hosts are connected to each other by what is known as the subnet. The subnet consists of the transmission lines (coaxial cables, fibre optic cables etc.) and the intermediate switching elements also called 'routers'. The main function of a router is to receive the transmitted data and then select an appropriate channel to forward it to the destination host or to another router. When a data packet arrives at a router it is stored in the router until the output transmission line is free and is then transmitted or forwarded to destination host.

The broadcast type wide area networks (WAN) use a satellite or ground radio system. All or some routers have antennas through which they can receive the incoming signal from the satellite. When a ground radio system is being used the routers can communicate between each other. It may also be possible that in a network, while some routers receive their outputs through their antennas, others are point to point type.

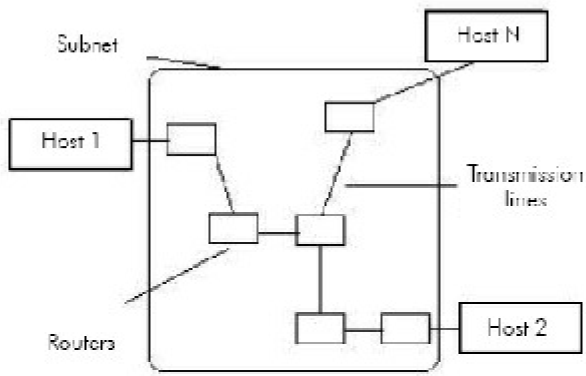


Figure 17.3: The Complete Network

ROUTING

When data is to be transmitted between two remote machines using intermediate machines, certain routing techniques (such as a routing algorithm in the intermediate machine) have to be applied. The intermediate machines may be termed as one of the following:

1. Gateways or routers
2. Repeaters
3. Bridges

We shall discuss each of these in detail as follows:

Gateways or Routers

Gateway is one of several types of communication servers. The function of a gateway is to allow two or more dissimilar networks to communicate as a single logical entity. The two machines that have to transfer data between themselves may have different operating systems (OS) or their transport protocols may be different. It is then the job of the gateway to connect such machines. Gateways, in general, are also called routers. It may be possible that exist several routers between the source and the destination machine. When a packet of data is transmitted from one router to another it is stored in the intermediate router until the communication channel is free and then it is forwarded.

Repeater

A repeater receives the incoming signal, repeats it or amplifies it and retransmits the transformed signal. After certain distances the signal experiences a loss of power hence a repeater is required to boost the power of the signal. By using repeaters the network can be extended but only finite extension is possible due to physical constraints such as noise. As the signal travels a certain distance some form of disturbance (referred to as noise) is added to it. When the repeater amplifies the signal the noise also gets amplified, hence over a large distance it may be possible that the signal becomes unrecognizable.

Bridges

A bridge is a device that is used to connect two networks so that they are able to perform as one. A bridge can also be used to connect two networks that use the same technology, such as the Ethernet network and the Token Ring network. One of the main functions of the bridge is to partition one large network into two networks which subsequently increases the performance of the network.

We shall try to explain the functioning of a bridge with the help of the following example.

Nodes 1, 2 and 3 are connected to LAN 1 and nodes 4,5,6 and 7 are connected to LAN 2

Suppose node 1 on LAN 1 wishes to communicate with node 6 on LAN 2. The data packet transmitted from node 1 on LAN 1 contains the address of node 6 on LAN 2. When the data packet is received by the bridge node it is checked for its address. If node 6 was connected to LAN 1 the bridge would not have broadcast the message to the other side, i.e. LAN 2, and would have left the message alone. But, in this case, the bridge transmits the message to LAN 2 from where node 6 collects it.

Thus, as is evident from the example, the bridge has partitioned the network into two and it is acting like a traffic policeman controlling the flow of traffic across an intersection.

Routing Techniques

Computer networks may use one of the following routing techniques:

1. Circuit Switching
2. Packet Switching
3. Message Switching

We shall discuss each of these methods in detail.

Circuit Switching

Circuit switching is analogous to a simple telephone call. A physical circuit is established between the two machines. Once the connection is established, the data transfer takes place and then the connection is released. Now, another location can be dialled and a new circuit can be established. The transfer of data using this type of switching technique is very fast but it is error prone. It is the responsibility of the user to check for errors and the integrity of the data.

Packet Switching

A Packet switching network divides the data to be transmitted into packets which are of a fixed size and carry error checking information with them. Each packet of data contains the address of its final destination when it is transmitted. As the packet moves through intermediate machines, it is inspected for its address and is accordingly routed to another intermediate machine. Messages being transmitted through this type of network are less error prone than those transferred through circuit switching networks. In case a particular packet is found corrupt on arrival, the destination machine can request the source machine for its retransmission.

Message Switching

In a Message switching network, the message as a whole is transmitted, i.e. it is not divided into packets. Each message contains the address of its final destination and it is upto the intermediate machines as to what path they want the message to go through. The message switching network is a store and forward network. Once the message arrives at an intermediate machine it is stored in the machine until the output line is free, and then transmitted. In case of heavy traffic on the transmission line, the messages are queued up and accordingly dispatched when their turn comes.

NETWORK TOPOLOGY

There are several different ways to organize the computers to form a network. These organizations of the computers in a network are referred to as network topology.

The different network topologies possible are:

1. Star Topology
2. Ring Topology
3. Bus Topology
4. Mesh Topology
5. Tree Topology

We shall discuss each of these in detail.

Star Topology

The star topology consists of a central computer to which all other computer terminals are connected. Two computers in this type of network cannot have direct communication. They can only communicate via the central computer. In case the central computer breaks down, the network becomes redundant.

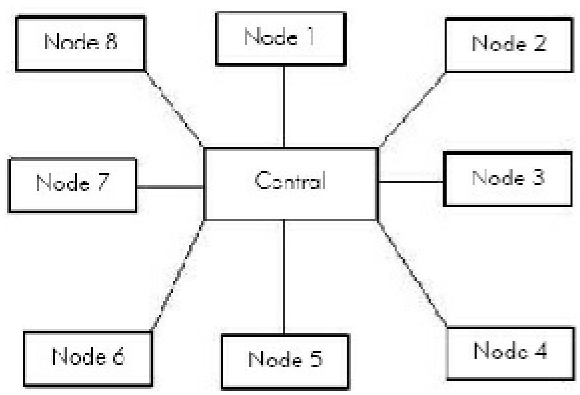


Figure 17.4: Block Diagram Depicting a Network in Star Topology

One very important advantage of this type of network topology is that in case any one node is faulty or is having problems, it can be isolated from the network without affecting any other terminal.

The star topology is the most commonly used network topology in data communication today. The performance of the system is good for moderate load. However, when traffic is high, the system may have some problems.

A disadvantage of star topology is that two terminals can't interact directly, i.e. they have to go via the central computer. This leads to no privacy in the network.

Another disadvantage is the network's dependence on the main (central) computer. If the central computer breaks down the entire network stops functioning.

The star network requires that each and every terminal be connected using a different cable. This leads to a somewhat increased cost for the cable as well as the installation of the cables.

Ring Topology

In the ring topology, the different computers are connected to each other forming a closed loop (in the form of a ring). The data is passed from one computer to the other in series until it reaches its desired destination.

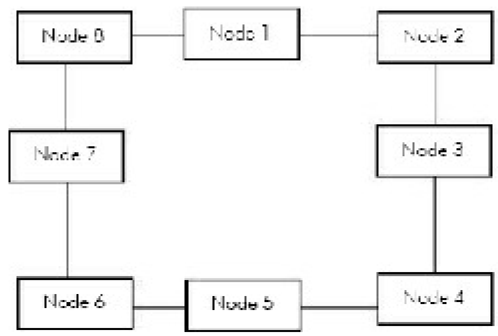


Figure 17.5: Block Diagram Depicting a Network in Ring Topology

There is no concept of a central computer in this case. The data is divided into packets when transmitted and each packet contains the address of the node that it is destined for. Unlike the star topology, this type of network requires lesser amount of cable and there are not much of installation problems either .

The biggest disadvantage of this type of topology is that the failure of one node may lead to the failure of the entire network. Since data from the source node passes through a series of nodes before reaching the destined node, the failure of even one node may lead to the network failure. However, the use of a bidirectional ring (data transfer in both directions is possible) can temporarily solve this problem by choosing a path that does not contain the faulty node. Unlike the star topology, it is relatively difficult to diagnose the faulty node in the ring network.

If the star topology provides less privacy, the ring topology provides zero privacy. However, the ring topology provides a better performance under heavy traffic as well.

It is also easy to add or remove terminals in a ring network which is not as easy in the case of a star network as only a certain specified terminals can be inserted into the central computer.

Bus Topology

The bus topology is also referred to as the multipoint topology. All nodes are connected to a bus that runs through the network.

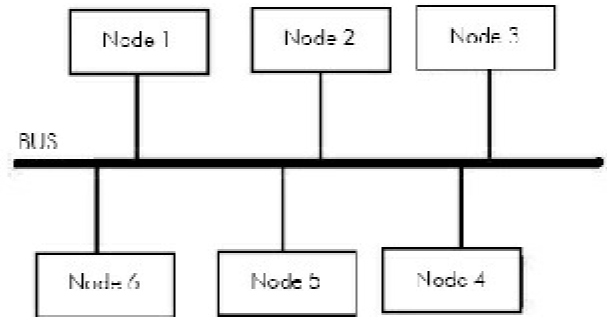


Figure 17.6: A Block Diagram Depicting a Network in Bus Topology

Each node is given a unique address. Information containing the address of the destined node is available at all the nodes but only the node with the specific address responds. The bus can transmit data in both directions.

If one node of the network goes faulty, the network can still remain working. However, the fault diagnosis of such a system is very difficult as each and every node has to be tested to find the faulty one. Once the fault has been found, the computer node having the fault is usually not disconnected from the network, but repaired on the spot.

The bus network topology is easy to extend as only new nodes have to be added along the bus. However, for a larger network, signal amplifiers known as repeaters may be used to strengthen the signal. The cable length and the installation do not pose much of a problem as the cable length required is short as compared to other topologies.

Mesh Topology

The mesh topology requires that every terminal be connected to every other terminal in the network.

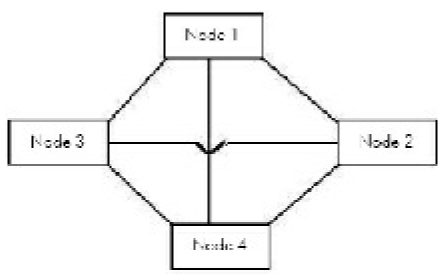


Figure 17.7: Block Diagram Depicting a Network in Mesh Topology

Hence, all the computers must have adequate number of interfaces for the connections to be made. Because of this requirement the installation is somewhat difficult. The length of cable required is also quiet high as compared with other topologies.

Data transfer using mesh topology is faster than the earlier discussed topologies. Mesh networks are also quite fault resistant. If a particular path fails, data can be routed via alternate paths.

To save on the cost of interconnections and to reduce the complexity of the system, we can make use of the hybrid mesh network. In this type of network, some of the main or more frequently used networks are connected to each other like a mesh network. The computer terminals are attached to these main terminals.

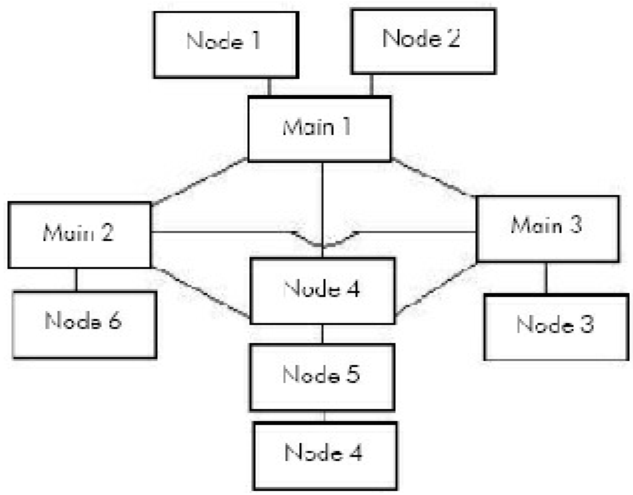


Figure 17.8: Block Diagram Depicting a Network in Hybrid Mesh Topology

Tree Topology

The tree topology requires the computers to be linked in a hierarchical way. Data transmission in this topology is relatively slower. The packets carrying the addresses of the destination nodes should have the complete address, that is, all the nodes above it in hierarchy also have to be mentioned.

The tree network like the star network is dependent on the main computer. Hence, the failure of the main computer shall lead to the failure of the entire network.

The tree network is very flexible as any number of nodes can be added or removed easily.

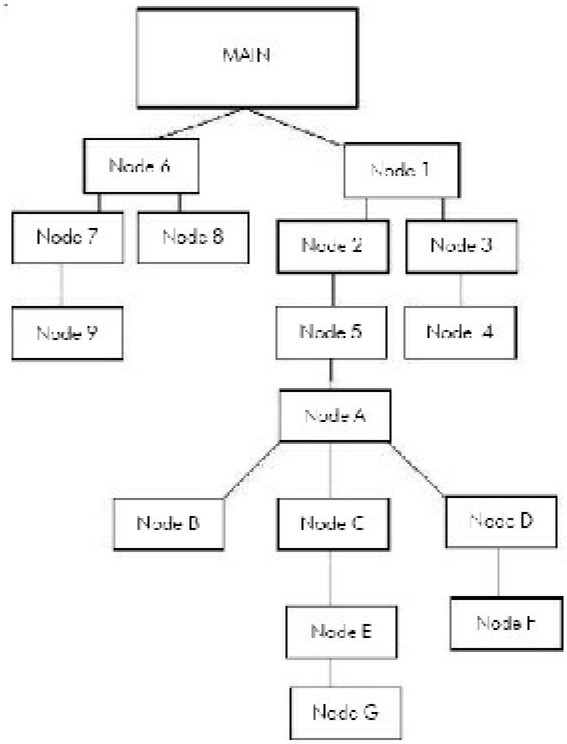


Figure 17.9: Block Diagram Depicting a Network in Tree Topology

TRANSMISSION TECHNOLOGY

There are two types of transmission technologies possible – broadcast networks and point to point networks.

Broadcast Networks

In this type of network, a single communication channel is shared by all the machines in the network. A packet of data to be transmitted contains the address of the destination machine. A broadcast network is very similar to a railway announcement system. When a particular train departure is announced, everyone present at the station hears it, but only those who have to board the train respond to it. The Bus and the Ring Topology are examples of Broadcast Networks.

Point to Point Networks

As the name suggests, the machines are connected point to point. Data is routed from the source machine to the target machine via intermediate machines or directly.

INTERNETWORKS AND THE INTERNET

A collection of different networks connected together or a collection of hosts connected together by a subnet is called an intenetwork. The hosts may be further connected to other terminals through a LAN or a WAN. An internetwork can be as large as you can imagine.

The internet is a very large internetwork that is available world-wide. The internet is the largest network in the world. It provides the world-wide web service implemented by the HTTP protocol.

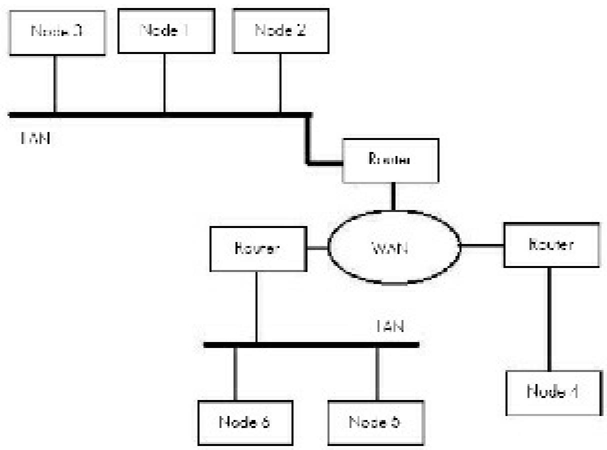


Figure 17.10: Internetwork

Accessing the Internet

Before you access the Internet, you must have an account with an internet service provider (ISP). You call the ISP on its phone number through your modem (connected to the telephone line). Once a connection is established, you are required to provide some kind of identification indicating the authenticity of your account. This is known as the login procedure.

After the login procedure and the successful authentication of your account, you are connected to the Internet. At this point of time, you require a communication software (web/network browser) that uses the hyper text transfer protocol (HTTP). One of the key roles that a communication software performs is to decide the proper speed between the communicating terminals.

PROTOCOLS

A protocol is a set of rules according to which the communicating computers communicate. If I wish to communicate with you, I can do so with the help of a commonly understood language, let's say English. However, if I can speak only French and you can understand only English then communication between us is going to be very difficult unless a third person volunteers to step in and act as a translator. Similarly, for computers to communicate, a common set of rules or protocols must be defined. The most common protocol used in networking is the TCP/IP (Transmission control protocol/Internet protocol). The Internet is predominantly based on TCP/IP.

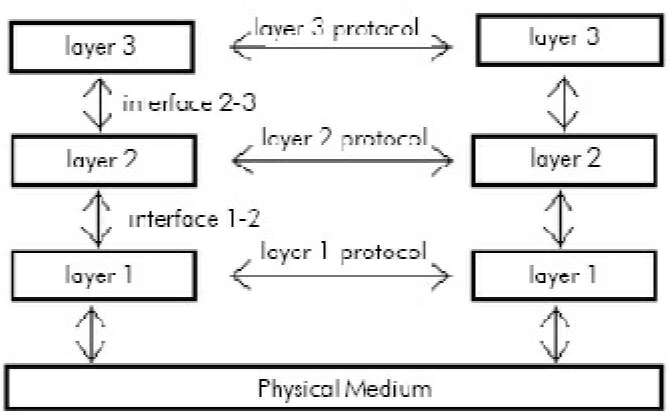
Layers

The networks are organized as a series of layers. Each layer has a specific function depending upon the protocol being followed.

Each layer provides certain services to the higher layers. How the offered services are being implemented is not known to the higher layer.

Shown below in the figure is a 3-layer network. The layer ‘n’ on one machine is called a ‘peer’ of layer ‘n’ on the other machine. In other words, the corresponding layers on the two communicating machines are called peers. It may seem from the figure that data transmission takes place between corresponding layers between the two machines, but it is not so. The actual data transmission takes place through the physical medium.

The layers on the transmitting machines add some control information to the data that is to be transmitted and pass it down to the lower layer. The lower layer again adds some more control information (e.g., it attaches a header to identify the sequence of the data packet) and passes it down to the next lower layer. At the receiving end, these headers are stripped off by the corresponding layers and the data packet is passed on until it reaches the final layer. Each layer receives and decodes the information sent by its peer.



Interface

The term interface here refers to the services the lower layer offers to the upper layers. Between the two layers is the interface. While designing a network, the functions that are to be performed by a particular layer should be very clear. Hence, well defined interfaces are a necessity for a successful network design. The upper layer passes what is known as an interface data unit (IDU) to the lower layer. The IDU may be divided into two parts - the interface control information (ICI) and the service data unit (SDU).

The service data unit contains the data being transmitted along with some control information that has been passed on from the still upper layers. The interface control unit contains control information (e.g., headers that are required by the peer entity on the receiving end).

OPEN SYSTEMS INTER CONNECTION REFERENCE MODEL

The basic reference model is the OSI model, declared in 1983 as an international standard. This model deals with connecting open systems (open for communication). The OSI model consists of seven functional layers on either machine.

At the top is the application layer, where end users interact with system or where application software is executed. At the bottom is the physical layer where logical information is converted into signals and transported through the physical transmission medium.

The function of each layer is defined keeping in mind the definition of the internationally standardized protocol. The number of layers in a particular model is variable. Only when a different level of abstraction is required should a new layer be created.

The active elements in each layer are called entities. It is the entities in each layer that interact with entities of other layers through well defined Service Access Points (SAP's) using specific interface protocols. A layer to the outside system behaves like a black box.

The number of layers should be large enough so that some sort of a similarity between the functions being performed in a particular layer is maintained.

As said earlier, the OSI model can be divided into seven layers each performing a distinct function. These layers are discussed in detail as follows:

The Physical Layer

The primary task of the physical layer is the transmission of raw bits over the communication channel. The physical layer has no knowledge of the structure of data that it is required to transmit. The physical layer does the following functions.

1. The physical layer involves the physical transmission of the data stream through the media. Connecting to routers, deciding the data rate and deciding which signal is to be transmitted first in case of multipoint signals, is the job of the physical layer.

2. The physical layer controls the mechanical characteristics of the transmission media.

3. Activation and deactivation of the physical connection.

The physical layer provides the following services to the data link layers:

1. The physical layer provides the data link layer with physical connections, data units and end points.
2. Since the physical layer transmits and receives data in the form of bits an indication of the sequence of these bits is necessary. This is provided by the physical layer to the data link layer.
3. When errors are detected in received frames, the physical layer requests for the retransmission of the frame. Hence, the physical layer also performs error detection.

The Data Link Layer

The functions performed by the data link layer include:

1. The data link layer defines the protocol to detect & correct errors that may occur during data transfer.
2. The data link layer receives the data from the physical layer in the form of bits. It is in this layer where the frame boundaries are created and the raw data is sequenced into frames.
3. The data link layer establishes and releases the link and maintains a supervision of the physical connection.
4. In case of a fast sender and a slow receiver the data link layer informs the sender of the buffer space available at the receiver's end in order to control the transmission rate.
5. The data link layer also supervises the traffic regulation for transmission in both directions.

The data link layer provides the following services to the network layer:

1. Sequence control.
2. Indicating transmission errors.
3. Indicating the quality of service.

The Network Layer

The network layer performs the following functions:

1. The network layer handles the routing functions by selecting primary or alternate routes for transmitting data.

2. The network layer provides the addresses of intermediate nodes or systems through which data is transmitted.

3. The network layer performs the multiplexing tasks in case more than one type of signal is to be transmitted.

   Hence, in other words, the network layer controls the operation of the subnet.

4. In case of two heterogeneous systems having different protocols, the network layer provides a common addressing system.

5. The network layer forms data blocks and segments at the source and reassembles them at the destination.

The network layer provides the following services to the transport layer:

1. Provision of network address.
2. Provision of network connections.
3. Identification of network end points.
4. Indicating the quality of service.
5. Sequence control.

The Transport Layer

The transport layer performs the following functions:

1. The transport layer has the job of receiving data from the network layer and delivering it within the destination machines. Multiple programs may be using the network from a single computer. The transport layer manages (sends and receives) the data of the these multiple programs within the network.

2. The transport layer and the layers above it are end to end layers. The lower layers carry on the bit to bit transmission of data routing each data packet through different paths. It is from the transport layer and upwards that the data starts getting sequenced and a meaningful conversation occurs.

3. The transport layer performs the error detection (end-to-end) of the data transmitted and sends a request for retransmission when necessary.

4. Again, in case of a fast sender and a slow receiver, the transport layer performs the data flow control.

The services provided to the session layer include:

1. Data transmission.
2. Establishing and releasing transport connections.

The Session Layer

The functions performed by the sessions layer are:

1. The sessions layer allows users on different machines to establish sessions between them. The session layer handles the details of the user names, passwords and other user authorizations. Each login is considered a session.
2. The data transfer rates, the method of error control, the mode of transmission (simplex, half duplex, full duplex) etc. are decided by the sessions layer.
3. The sessions layer inserts checkpoints (in the form of headers) in the data packets it transmits, so that just in case the connection gets disconnected the process can be continued rather than having to restart it.
4. The sessions layer, like the transport layer, provides the data flow control.

The services provided to the presentation layer are:

1. Establishing and disconnecting the session.
2. Indication of errors.
3. Performing synchronization (inserting checkpoints).

The Presentation Layer

The presentation layer performs the following functions:

1. The two interacting systems may be using different character code. For example, one system may be using the ASCII character code and the other might be using the EBCDIC character code. In order to ensure a meaningful exchange of data, the presentation protocol defines the rules on how the data will be presented and exchanged in a common neutral language.
2. The presentation layer, unlike the lower layers, is concerned with the syntax of the information transmitted. This layer performs the proper coordination of syntax and presentation profiles.
3. The presentation layer may also perform data encryption, data decryption and data compression etc., if required.

The presentation layer provides the following services to the application layer:

1. Syntax translation.
2. Data formatting (encryption, compression etc.).
3. Selection of syntax and presentation profile.

The Application Layer

The application layer performs the following functions:

1. The application layer provides the end user an interface with the system. This layer also controls the operating system functions.

2. The application layer performs an identification of the communication partners and establishes availability. The application layer also checks for authorization and validity.

3. The application layer checks for errors and requests for their correction.

4. The application layer, like the presentation layer, is concerned with the syntax of the data and hence, it performs a proper coordination of the syntax and presentation profiles.

The application layer provides the users with many services. Some of these are listed below:

1. File transfers

2. Database queries, insertions and deletions, remote job entry etc.

3. Electronic mail

We shall discuss two of the above three most commonly used services in detail.

File Transfer

To perform a file transfer between two systems, the fundamental requirement is a common protocol. In this section we shall discuss about file transfer protocol (FTP). The file transfer protocol (FTP) is an application of the TCP/IP. The file transfer protocol gives the user an access to a remote machine file system. The user once given access can browse, upload or download files. The user needs an FTP client application and the remote host should have an FTP server component. The FTP client application enables the user to send commands to the FTP host. The FTP server component processes these commands and performs the necessary action. The FTP is also an Internet tool, since the Internet uses the TCP/IP. Thus, the file transfer protocol can also be used to copy files from an Internet site or for uploading a file to a remote net server.

Electronic Mail

Electronic mail is a fast and efficient method to exchange messages and other data. To interact through the electronic mail one needs to have an
e-mail account. Once the account is created the user is assigned an electronic mail box. The user can send messages to other users through his mail account and can receive incoming messages in his mailbox. The messages are instantly delivered and it is not necessary for the recipient to be present while the mail is delivered to his mailbox;

he/she can scan the mail later.

The electronic mail system allows a very easy merging of a particular message. Just typing the e-mail user names of all the recipients would deliver the message to each of them. Moreover, the user can put a restriction to the delivery of messages. It is also at the user's discretion as to which sender's message he wants to receive in his mail box.

Choosing the right kind of e-mail service

E-mail accounts for more than 50% usage of Internet. By using the right kind of e-mail services one can save a lot of time and money. Here is a list of all the main types of e-mail services available on the net, along with their advantages and disadvantages (nothing is perfect!). Also listed are some of the free e-mail service providers for each type of service available on the Internet. Users with an internet account should go for POP mail. The choice depends on the user and what service suits him personally.

Types of e-mail services

There are 3 main types of e-mail services, each having some advantages and disadvantages.

POP Mail

POP mail services store your incoming messages on a server and you download the messages using an e-mail software package (Eudora, Netscape messenger, Outlook express etc.). Once they are downloaded, the messages are stored on your PC. POP mail services are similar to the e-mail service offered by most ISP's.

Advantages

a) You can work offline, compose or read messages, and just connect to send mail or download new messages.

b) The mail program used by your browser (Outlook express for Internet explorer, Netscape messenger for Netscape) can be configured to receive and send all your e-mail automatically. This is very useful when you are browsing the net and find a link to an e-mail address where you want to send any mail. With the mail program properly configured, you can send the mail immediately without going to your web based e-mail service providers' site.

c) Since all messages are stored on your computer after you download them, you can refer to them at any time without connecting to the Internet and easily cut and paste the information into other applications.

d) Once downloaded, the messages can be automatically deleted from the server.

Thus, only new messages would be available each time you connect to receive your mail.

e) You can also use powerful and intelligent e-mail software, which may include spelling check options, clever filtering options and all kinds of other features.

Disadvantages

a) The biggest disadvantage of POP mail is that you can not access your e-mail while "on the road", i.e., on another computer since you need the e-mail software configured for it.

b) If you sign up with a free POP mail service, you can generally expect to receive unwanted advertisements or spam mails in your mailbox.

c) The signing up & setting up procedure is not as easy as a web based e-mail but once configured you will find it easy to download and send mail.

Web-based E-mail

With web-based e-mail, your e-mail is stored by the free e-mail service provider you signed up with; thus you have to log into the site you signed up at in order to gain access to your e-mail. Most of the large free e-mail providers offer web-based e-mail since it is relatively easy to implement. Different web-based free e-mail services come with different functionality, such as online spell-checkers, personal address books, distribution lists etc.

Advantages

a) You can easily log in and collect your e-mail from any web browser.

b) There's no need to configure any program in order to access e-mail.

c) It is easier to register and no setup is required.

Disadvantages

a) It is time consuming, i.e., you got to go to the e-mail providers' site, log in, wait for all your messages to show up; then read each message individually and stay connected on the net while you do so. All this requires a lot of your time & consequently money on the connection.

b) Many web-based services take advantage of advanced functions such as Java in order to provide an attractive interface. You will therefore, need to have latest web browsers in order to keep your range of options open (generally you need Netscape 3.x or better or IE 3.x or better).

c) Most web-based services cannot match the functionality of a good e-mail package. Some common problems are server down, high traffic etc. (making access slow and reading and sending mail difficult & time consuming).

d) Advertising banners rotate as you read your e-mail. This can increase your access time.

Mail Forwarding Services

Mail forwarding services, as the name implies, do not offer you a NEW e-mail account. Rather, they pass e-mail to your existing account (POP or web-based), but offer a different mailing address. Therefore, you need an e-mail account before you sign up for mail forwarding services.

Advantages

a) E-mail forwarding services let you continue to use your existing e-mail account given to you by your ISP. If you change the ISP at any time, just change the e-mail address your e-mail is forwarded to, and it will automatically be redirected to your new address.

b) Forwarding services let you choose a memorable or fun name, often much more distinctive than your current address.

Disadvantages

a) With an e-mail forwarding service, you are putting another layer between the sender and your email account. This means that you are twice as exposed to network problems; if either the forwarding service or your e-mail account is down, the e-mail will not get through.

b) Generally, mail forwarding services make money by gluing a small advertisement at the top or bottom of each e-mail message they forward (or sometimes both).

List of free e-mail service providers

POP Mail

- Amex Mail (www.amexmail.com)

  This service is provided by USA.NET

- Crosswinds (http://home.crosswinds.net)

  Free POP mail address and free web space (unlimited for personal sites, 25MB for business sites). You cannot use your free e-mail address to run a mailing list. Not very reliable and servers remains down at times.

- Newmail (www.newmail.net)

  Newmail offers web-based and POP mail services, plus 5MB of space for storing messages and address books, filters etc. Does not offer SMTP.

- PeachWorld Network(www.peachworld.com)

  You can send/receive messages up to 1.5MB here.

- POPAccount(www.popaccount.com)

  Free web-based and POP mail service with no advertisements attached to POP mail messages.

- SoftHome(www.softhome.net)

  I am personally using this service for the last 6 months and have had no problems whatsoever. Also till date their has been no spam mail in my inbox.

- ForFree(www.forfree.at)

  Very fast-loading site; provides free POP3/SMTP e-mail, as well as free site hosting (5MB) and free mailing list services.

- Freemail(www.freemail.everperfect.com)

  Does not display advertising in messages.

- Friendly E-mail (www.mypad.com)

  Also offers free web-based e-mail and a choice of over 3 dozen different domain names.

- HotPop(www.hotpop.com)

  Free POP mail. MIME format supported. There are no ads in the messages; instead HotPop will send you separate advertisement from selected advertisers. You can also forward e-mail to an existing account. HotPop comes with a choice of domain names. HotPop filters spam before it hits your mailbox.

Web based e-mail

Most of you maybe using this service and may know lot of free e-mail providers but here is my own list:

- MrPost (www.mrpost.com)

  Special service enables you to add web-based e-mail to your own site FREE of charge. Also offers web-based instant messaging and chat.

- MyOwnE-mail (www.myownemail.com)

  Over 200 domain names to choose from. Free web-based mail, plus mail forwarding services at $11.95 per year.

- MuslimE-mail (www.muslimemail.com)

  This free e-mail service also offers free web hosting for muslims and many other services. Other domain names are available at a premium.

- GhanaMail (www.ghanamail.com/emurl)

  A no-questions-asked web-based e-mail service. All you need to do to sign up and choose a user name and password.

- gurlmail (www.gurlmail.com)

  Another Who-Where-powered free e-mail service. Gives 4MB storage for e-mail messages.

- HotMail (www.hotmail.com)

  The largest web-based free e-mail service, now a part of the Microsoft family. Most of you must be having a HotMail account. If you decide to go for POP mail after reading this article and do not want to change from Hotmail then there is a good news for you. Hotmail can support POP-mail-like functionality through a free third-party utility called CwebMail (available at www.cwebmail.com).

- Eudora Web-Mail(www.eudoramail.com)

  Free e-mail service

- Fastermail.com(www.fastermail.com)

  Free e-mail service.

- 123india.com(www.123india.com)

  India's very own e-mail service.

Mail forwarding services

Automatically redirects your e-mail-address.

- Easy To(http://easy.to/remember)

  An intriguing free service that provides free e-mail forwarding in the form username@easy.to. Seven domain names to choose from.

- FlashMail(www.flashmail.com)

  FlashMail offers free web-based e-mail, POP mail, mail forwarding and retrieval of e-mail from an existing account, all via a very clean and simple interface.

- Grabmail(www.grabmail.com)

  Free e-mail service offers 5MB of disk space, folders, an address book, vacation

  Auto responders, access to your existing POP mail accounts and more. Grabmail also offers mail forwarding facilities.

- IName(www.iname.com)

  Also offers free web-based e-mail services; IName powers the free e-mail offerings of dozens of large sites.

- NetForward(www.netforward.com)

  A choice of over 20 domain names. Free mail forwarding service that offers to remove the "tag-line" in messages for a one-time fee of $9.50.

- Nederlands.com(nederlands.com)

  Free e-mail forwarding address at "Nederlands.com" or one of over 1,000 sub-domains.

- USA.NET(www.usa.net)

  The company behind NetAddress, USA.NET also offers its own free e-mail under the usa.net domain.

- Bigfoot(www.bigfoot.com)

  Bigfoot allows e-mail to be forwarded to up to 5 separate e-mail accounts automatically. It also offers various mail filtering options.

- Bitmail(www.bitmail.com)

  Private users can choose any e-mail address they like; businesses can choose an e-mail address based on their telephone number. Only the first year's service is free.

REVISION EXERCISES

1. The distributed queue dual bus system is used in-
   i. LAN
   ii. WAN
   iii. MAN
   iv. PAN
2. Which of the following have the highest transmission rate-
   i. LAN
   ii. WAN

iii. MAN

iv. PAN

3. Differentiate between LAN and WAN by listing down the merits and demerits of each over the other? Which of the two is used for the 'Internet'.

4. Why are the WAN's also referred to as long haul networks (LHN's)?

5. List down the disadvantages of using Star topology?

6. Which of the following topologies consist of a central(main) computer-

   i. Ring topology

   ii. Mesh topology

   iii. Star topology

   iv. None of the above

7. Which of the following topologies is most easily extensible-

   i. Ring topology

   ii. Bus topology

iii. Star topology

iv. Tree topology

8. In case a particular node fails which of the following network topologies is still most efficient to work on –

i. Ring topology

ii. Mesh topology

iii. Star topology

iv. Bus topology

9. Which of the following topologies is the fastest -

i. Ring topology

ii. Mesh topology

iii. Star topology

iv. Bus topology

v. Tree topology

10. Define broadcast and point to point type networks. Give example of each.

11. State whether the following statement is true or false. Give reasons.

‘A bridge is like a smart repeater.’

12. Fill in the blank :

‘A bridge ____________ a large network.’

13. What do you understand by the term protocol?

14. Given below are some abbreviations, write their full form.

i. TCP/IP

ii. FTP

iii. HTTP

iv. HTML

v. ICI

vi. IDU

vii. ASCII

viii. OSI

ix. SDU

x. LHN

xi. MAN

15. Which layer, of the following layers in the OSI model is not an end to end layer-

i. Physical layer

ii. Transport layer

iii. Network layer

iv. Data link layer

16. Which layer, of the following layers in the OSI model has the function of providing the authorization to the correct user-

i. Session layer

ii. Transport layer

iii. Network layer

iv. Presentation layer

17. Which layer, of the following layers in the OSI model is most concerned with the syntax of the data -

i. Presentation layer

ii. Session layer

iii. Network layer

iv. Data link layer

18. Differentiate between Pop mail and Web mail? Which type of e-mail service would you prefer? Give reasons.

Chapter 18: INTERNET

Internet is the name for a vast, worldwide system consisting of people, information, and computers. It is so huge and complex that it is beyond the comprehension of a single human being.

The roots of the Internet lie in a project called the ARPANET, which was sponsored by the United States department of defence–Advanced Research Projects Agency (ARPA). The department of defence was interested in building a network that could maintain itself under adverse conditions. (A NETWORK is simply two or more computer connected together).

The project was started in 1968 and soon evolved into a more general goal of developing techniques to build a large-scale network. ARPANET continued for years and was gradually phased out after having been officially declared completed. By then the technology to connect computers reliably and economically had been developed and today the ARPANET's spiritual descendents form the global backbone of what we call, INTERNET.

NETWORK

The term network refers to two or more computers connected together. There are a number of reasons to connect computers into networks, but the two most important are:

1. To allow human beings to communicate;
2. To share resources

A local area network, or LAN, is a network in which the computers are connected directly usually by some type of cable. When we connect LANs together, we call it a Wide Area Network or WAN. Most wide area networks are connected via a variety of other technologies, such as satellite links telecommunication links and telephone lines. The wide area connections for most of the Internet travel over some telephone system or another. Indeed, the bottleneck in establishing Internet service within developing countries is usually the lack of a reliable phone system. The LANs are connected to each other by routers in order to form WANS. Routers are also used to connect smaller WANS to form even larger WANS.

CLIENT AND SERVERS

Internet is populated by two types of computer programs: servers and clients. Servers are programs that provide resources. Clients are programs that you use to access those resources. The internet contains millions of computers as well as a lot of wires, cables, telephone lines, satellite links, and so on. And the whole purpose of all of this equipment is simply to let the clients and the servers talk to one another. In other words, the Internet was constructed so client programs (which you use) can talk to server programs (which provide resources).

HOST AND TERMINALS

As you use the Internet, you will also encounter another important pair of technical terms: host and terminal.

These are two meanings for the word " host". Within the Internet, each computer is called a host (or mode). Within a times-sharing system- such as Unix - main computer, which supports each user on a separate terminal, is also called a host. Of course, if such a computer were connected to the Internet, it would be both a timesharing host and an Internet host.

When you have your own computer, you interact by using the keyboard, screen, and mouse. These devices are part of the computer. With a multi-user computer, each person has his or her own TERMINAL to use. A terminal has a keyboard, screen, perhaps a mouse. All of the terminals are connected to the host, which provides the computing power for everybody. This arrangement is called a timesharing system.

TCP/IP

The Internet is built on a collection of networks covering the world. These networks contain many different types of computers and somehow, something must hold the whole thing together. That common characteristic is TCP/IP.

To ensure that different types of computers can work together, programmers write their programs using standard PROTOCOLS.

A protocol is a set of rules describing, in technical terms, how something should be done on a computer. For example, there is a protocol describing exactly what format should be used for sending a mail message.

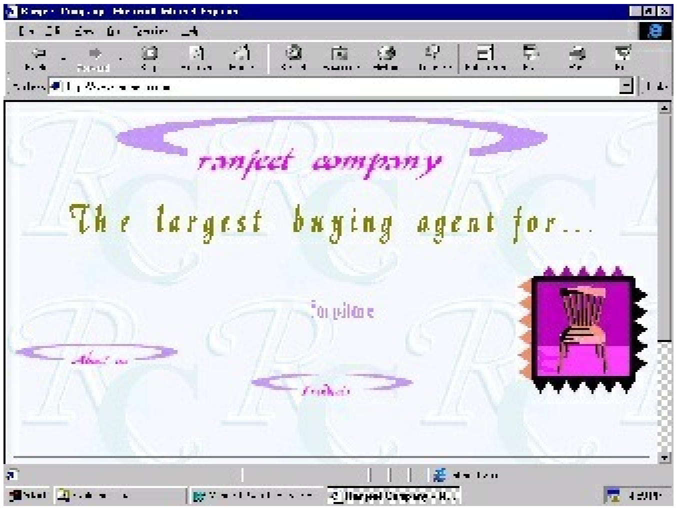
TCP/IP is a common name for a collection of more than 100 protocols used to connect computers and networks. The actual name, "TCP/IP", comes from the two most important protocols: TCP (Transmission Control Protocol) and IP (Internet protocol).

Within the Internet, information is not transmitted as a constant stream from host to host. Rather, data is bound into small packages called PACKETS. For example, say you send a mail message to a friend on the other side of a country. TCP will divide the message into a member of packets. Each packet is marked with a sequence number, the address of the recipient, and the address of the sender. In addition, TCP inserts some error control information. The packets are then sent over the network, where it is the job of IP to transport them to the remote host. At the other end, TCP receives the packets and checks for errors. If an error has occurred, TCP can ask for that particular packet to be resent. Once all the packets are received correctly, TCP will use the sequence members to reconstruct the original message. In other words, the job of IP is to get the raw data - the packets -from one place to another. The job of TCP is to manage the flow and ensure that data is converted properly.

So TCP/IP is a large family of protocols used to organize computers and communication devices into a whole network. The two most important protocols are TCP and IP, IP (Internet protocol) transmits the data from place to place while the TCP (transmission control protocol) makes sure it all works correctly.

So the INTERNET, is a network of networks as well as, is a network of cooperating organizations and companies. The Internet is a symbol of how computers around the world are connected together. It is the rule of protocols and operating systems and its purpose is to transport data. What that data is and what you use the Internet for, is another matter entirely. You can put information on your computer (connected to the Internet) and let all other computers elsewhere on the Internet access that data. This is the realm of web servers and web clients, respectively.

WWW : WORLD WIDE WEB



Most early Internet programs were command-line programs. The World Wide Web has changed all that. Instead of requiring you to know archive commands, the World Wide Web gives you a graphical view of the Internet. The web is easy to use; it is easy to create web pages and to link them to other web pages. You don't have to learn esoteric programming languages to create a simple web site. (But the more complex web sites do require some programing).

HYPERTEXT

Although the World Wide Web uses the Internet, the web is based on another concept entirely. That concept is hypertext, and is referred to in the names of the standards and protocols that the World Wide Web uses, i.e. Hypertext Marking Language (HTML) and Hypertext Transfer Protocol (HTTP).

Hypertext explores the idea that electronic documents, unlike paper documents, don't have to be static. When you ran across an interesting work or concept in a printed newspaper article, for instance, you must go to a dictionary or encyclopedia or library to look up the references yourself. The most the article can do is to cite these references in footnotes.

However, if a hypertext article is displayed for you on a computer screen, the computer can bring the references right to you. Instead of merely giving the reference name, the hypertext article contains pointers to a web of interrelated documents; each with links to move and cut ideas with similar subjects or examples. To access these documents, all you have to do is click the reference.

In the initial years, the web pages used to be static pages. It was limited to interlining of various text-based documents. Then new technologies came and due to these, web pages can be made more dynamic e.g. Displaying different quotation each day on the web page, the colour of the web page changes after each minute, a graphical counter displaying no. of hits on the site, etc. The client side dynamism is provided by :

JavaScript: A scripting language based on the syntax of Java. JavaScript was created by Netscape.

Jscript: A scripting language by Microsoft. It can be called as a Microsoft's version of JavaScript.

Vbscript: This scripting language was created by Microsoft base on the syntax of visual basic only. Internet explorer supports vbscripts.

ActiveX: These are the controls given by Microsoft. ActiveX is only supported by Microsoft browsers (e.g. Internet explorer). Active X is the technology for extending the user interface capability of HTML and scripting languages. ActiveX controls such as buttons, pick lists, menus, and check boxes allow you to embed controls in your HTML forms that make them look like windows applications.

Java applets: These are small applications that run inside the web browsers. The only drawback with Java applet is that it takes a lot of time to download. This makes navigating the web site, containing applets, a bit slower.

The server side dynamism is provided by :

CGI: A standard for starting programs on the web server computer that returns dynamically created HTML documents to the HTTP service for transmission to the remote client. CGI stands for Common Gateway Interface. The popular languages, in which CGI scripts are written, are PERL, C and C++.

Java servlet: servlets are the server-side application written in Java. The major advantage of using Java application is that it can run on any platform. Java can run on any machine. Also Java is similar to many industrial programming languages except that it is not compiled to the native machine language of the target computer.

ISAPI: ISAPI stands for Internet Server Applications Programming Interface. Microsoft developed the ISAPI to make dynamically generated web pages.

ASP: ASP stands for active server pages. ASPs are HTML pages that contain scripts written in Vbscript or Jscript, as well regular HTML text. ASPs have the extension .asp.

The World Wide Web protocol (HTML, HTTP) allow any Internet site to provide (or host) web pages. Any page can refer to any other web page, even without the knowledge of the other page. The World Wide Web is the most visible Internet tool today. It presents information textually as well as graphically and turns the Internet into an information resource and marketing tool unlike any other. You can use the web to search for product information, download changes to software and firmware, keep abreast of information published in electronic newsletters, research any subject from auto mechanics to zoology, and much more.

UNIFORM RESOURCE LOCATOR (URL)

URL stands for Uniform Resource Locator, which is simply an address of a document on the web or, more accurately, on the Internet. Although a URL can look complex and long, its made up of four basic parts-protocols, host name, folder name, and file name-each of which has a specific function.

E.g. http://www.webconnet.com/virtual/index.html

All URLs follow this format regardless of the service being used or the document being retrieved.

Protocol: the first element in the URL is the protocol. This is the service that provides the resource, followed by a colon. The default taken is http: if you don't specify other service. The protocol specifies the computer language used to transfer information. Specifically, a protocol tells the browser where the information is located (for example, on a web server, an FTP (file transfer protocol) server, a local hard drive, and so on). The protocol tells the browser what to expect from the document retrieval process.

Table 1: Common Protocols

Protocol	Use
http://	For HTML documents and associated files on the web
ftp://	For documents on the FTP server
Gopher://	For documents on the Gopher server
telnet://	To open a telnet connect to a specific host.

Host Name: host name is the server that contains the resource, preceded by two slashes (either in the form of a domain name or an IP address). In other words the hostname is the name of the server that holds HTML documents and related files.

E.g. In the previous example, the hostname is www.webconnet.com.

Folder Name: folder names give document on the servers file system. Folders perform the same function on a web server that they perform on your PC
(i.e. they organize documents). There's virtually no limit to how deep you can nest folders, and there's no limit as to what files the folders can contain.

File Name: file names are the names of specific documents. It identifies the file (an HTML document, an image, a text file, and so on) to be displayed. In the above example, the file index.html is displayed. This file is kept in the folder virtual.

WEB BROWSERS

Web browsers are applications that retrieve content in the form of HTML from WEB

SERVERS. Browsers keep track of the users input actions, for example; clicking buttons or selecting links-and executing those actions.

By 1992, the basic idea of hypertext-data containing links to other data had been explored and was widely accessible on the net. However, the number of people using the web was still small. This was because the principal web client programs ran under text-based Unix systems and were awkward to use.

This all changed in 1993, when Mark Andersen, then a student at the University of Illinois, released a new program called Mosaic. Mosaic was the original graphical web browser. Mosaic used the original text web browser, Linux as a model. After the release of Mosaic, the popularity of the World Wide Web exploded. Mark Andersen formed a new company Netscape and released Netscape navigator.

After the release of navigator 2, Microsoft woke up to the Internet and realized the vast potential of this entirely new market. In short time the company released Internet explorer, which in its original version wasn't very compelling.

Other web browsers were spry Mosaic, Lynx, HotJava etc. Spry Mosaic is a licensed descendent of NCSA Mosaic. Spry has licensed it for use as the CompuServe web browser. Lynx is the original text only web browser developed at CERN to support only pure HTML. HotJAVA is a web browser that Sun wrote entirely in Java as a demonstration of the programming power of the Java language.

Netscape communicator (initially called as Netscape navigator) and Internet explorer are the two browsers that are most popular. Regardless of which browser you use, web browsers may support some or all of these features:

- Bookmarks for favorite web sites
- Multiple browsing windows
- Frames or multiple views within a window
- Secure data transmission
- Java and other languages support
- Web interface to FTP and Gopher Internet sites.

IP ADDRESS

If you want to get connected to another computer, you need to know the computers address. An IP (Internet protocol) address is an identifier for a particular machine on a particular network; it is part of a scheme to identify computers on the Internet. An IP member consists of four sections separated by periods. Each section contains a number ranging from 0 to 255. For example 202.50.2.3

These four sections represent both the machine itself and host, and the network that the host is on. The network portion of the IP address is allocated to Internet Service Providers (ISP) by the internic, under authority of the Internet Assigned Numbers Authority. ISPs then assign the host portion of the IP address to the machines on the networks they operate.

They are 5 classes of IP addresses. Class A, class B, Class C, Class D, and Class E. The IP addresses have the following characteristics in common:

- IP addresses are unique
- All machines connected to the Internet agree to use the same scheme for establishing an address.

DOMAIN NAME

A domain name is a way to identify and locate computers connected to the Internet. No two organizations can have the same domain name.

A domain name always contains two or more components separated by periods, called "dots". Some examples of domain names are: www.nasa.gov, netscape.com, tcs.co.in, etc.

The top-level portion of a domain name describes the type of organization holding that name. The major categories for top level domains are:

- Com-commercial organizations
- Edu-educational institutions
- Net- organizations involved in internet operations
- Org-miscellaneous organizations e.g. Non-profit groups, etc.
- Gov-united states federal government entities
- Country codes- a two letter abbreviation for a particular country. For example, "in" for India, "uk" for United Kingdom or "fr" for France, etc.

Domain Name Service (DNS)

Domain name service (DNS) enables internet clients and hosts to refer to one another using human-readable names like www.microsoft.com, rather than IP addresses like 207.68.156.61, which are harder to remember and convey no information about the site.

Each domain name corresponds to numeric IP (Internet protocol) addresses. The Internet uses the numeric IP address to send data. For instance, you may be connecting to a world wide webserver with the domain name e.g. www.yahoo.com, but as far as the network is concerned, you are connecting to the web server with the IP address associated with that domain name. The numeric IP addresses are the official addresses of the net. Domain names are used only for the convenience of human beings. This means that, before a domain name can be used, it must be translated into a numeric IP address. All of this is done automatically by an Internet service called DNS.

Every time the client programs need to connect to another computer, they will have to call upon a special server, called a DNS SERVER, to translate a domain name into an IP address. The DNS SERVER your computer uses will probably be the remote host that provides your Internet connection. The domain system is a collection of databases that contain information about domain names and their corresponding IP addresses.

INTERNET SERVICE PROVIDERS (ISP'S)

Internet Service Providers are companies that connect you to the Internet. These companies form the backbone of the Internet.

In order to access the Internet using your phone line, you will need to establish an account with an Internet service provider. To start service, you will have to register with that provider and choose either a TCP/IO or shell account or both. Once you register with an ISP, you get a user name, a password and phone number(s) to dial. You can change your password whenever you may want to. To establish and get connected to the Internet, your communications program dial the Internet access number. Once you get connected, a window will prompt for your username and password. After you enter your user name and password, you get connected to the world of Internet.

Choosing an ISP is an important decision. There are many factors based on which you choose your ISP. For example, at present the ISP’s in Delhi are Mantra Online, VSNL and Satyam. ISP’s vary in their services, price, hour’s package, etc. One ISP may be offering better services but charging more for each hour of Internet access. Here are certain points to consider before going in for a particular ISP.

- If it’s service can be accessed with a local phone call.
- Is the prices are competitive.
- Does the provider have enough phone lines.
- Does the service provider offer full internet access.
- Is the connection fast enough.
- Does he provide you space for launching your own web page.

INTERNET SECURITY

Internet security is one of the hot topics in discussion these days. Initially when the idea of Internet germinated, no one might have thought of security but now security is one of the prime issues to be tackled. There is no one who is governing the Internet. Anybody can login to the Internet. Millions of computers are connected to the Internet. This makes the computers and Internet vulnerable to security attacks.

The threat to security can be in many ways:

- Some hacker may break into your server and modify the files kept here
- Every day hundreds of viruses are created which can freely flow through Internet.
- Due to electronic commerce, the credit card credentials can be read by a professional hacker. This is a dangerous situation
- Secret military and government data can be stolen.

Many methods are available to implement security mechanisms:

- If you attach your local area network directly to the Internet through a router, you risk intrusion into your network from the Internet. Many routers now function as devices called firewalls, which allow you to restrict the information flowing through the firewall by type (for instance, only HTTP or FTP information), IP address of the computers, and many other factors. Firewalls are the best way to protect your network from intrusion via the Internet.
- Some ISPs provide a firewall service. They will automatically filter traffic to and from your network by type; if you desire
- Always keep the latest version of any good virus scanning software e.g. Mcafee, Norton, dr. soloman, etc. Whenever you download any material from Internet, get it thoroughly scanned by the virus scanner software. It may contain a virus, which may effect your files or computer as a whole.

INTERNET REQUIREMENTS

Hardware Requirements

You can use any of the PC models coming today e.g. Intel Celeron, Intel PII, Intel PIII, AMD K6, CYRIX MII, etc. The CPU of 350 MHz and above gives a good performance.

Your computer should have atleast of 16-Mb ram to have good navigation on the net. The AGP card should have at least 4mb ram. This helps in watching the graphics/movies on the Internet effectively.

You should have a telephone line or ISDN (integrated services digital network) connection. ISDN connection has more bandwidth as compared to a single telephone line. A modem is also required. Modem stands for modulator/demodulator. The computer operates on digital signals, whereas the telephone lines operate on analogy signals. So an additional piece of hardware, i.e., modem is connected between the computer and the telephone line. Modem converts the digital signals to analog and vice versa. Modems are inbuilt or they can be connected externally. The good modems available in the market are from the companies BOCA, US ROBOTICS, etc. A modem can be an ordinary modem or a fax/voice modem. The fax/voice modem in addition to data, can also carry, voice on the net.

Software Requirements

We should have connecting software and web browser software.

Internet can be called upon from any operating system e.g. Windows 98, Windows NT, Linux, Unix, etc. The two most widely used web browsers are Internet explorer and Netscape communicator.

WEB SEARCH ENGINE

A web search engine is an interactive tool to help people locate information available via the World Wide Web. Web search engines are actually databases that contain references to thousands of resources. Users are able to interact with the database submitting queries that “ask” the database if it contains resources that match specific criteria.

There are many search engines available on the web. A web search engine provides an interface between the user and the underlying database.
The interface presents the user with a place to type in a search string, which may be a word, phrase, date or some other criterion, and a way to submit the request.

A web search engine runs the search string against the database, returns a list of resources that match the criteria, and displays the results for the user. Many web search engines use “fillout” forms as an interface, and support complex queries. Many also include instructions and help in searching the debates. Because web search engines can use hypertext, users are able to link directly to resources listed in the results display. Some of the most common search engines are:

- Lycos
- Yahoo
- Excite
- Webcrawler
- Infoseek

NET SURFING

Internet browsing or net surfing is the process of visiting the different web sites on the Internet hosted by the various companies, organizations, educational institutions, magazines and individuals. The Internet contains a wealth of information that can help you in any sphere of activity. Armed with a good Internet browser, you can easily get around to the myriad of sites, gathering imperative information, conducting market research, reading publications and staying in touch with what's happenings at your business associations.

When you are new to Internet, you will definitely want to surf the net and soon this will become an addiction. Once hooked to the net you will soon forget how much time has elapsed. With the hour limitation and lost of local calls, surfing is a costly affair. So after the initial enthusiasm is over, one should try to make the best use of the time spend on line.

While researching for a particular subject on the net, before actually getting connected, spend some time with a paper and pencil. Write down the possible key words that you are going to search and if possible write down the URLs of all the sites that you are going to visit. Then use a good search engine and efficient searching techniques.

Make use of the favorites, or bookmarks feature of the browsers. This will save time because you don't have to type-in the URL every time. You need to visit a site that is book-marked. So if you think that you will be coming back to a particular site, then add it to the favorites or bookmarks. Most browsers provide the facility to organize the bookmarked URLs under different categories.

Another time and resource saving technique during net surfing is called off-line browsing. Most of the new browsers now have the off-line browsing feature. You just have to enable the off-line browsing option and the browser will download and store all the pages that you have visited in your computer hard disk (cache). So once you have visited all the sites that you wanted to go, you could disconnect from the net and review the documents or pages off-line.

With the number of users increasing at an exponential rate, getting connected to Internet is a big challenge these days. So you can save a lot of time and energy (and avoid lot of frustration) by connecting during the non-peak hours (early mornings and late nights are the best).

INTERNET SERVICES

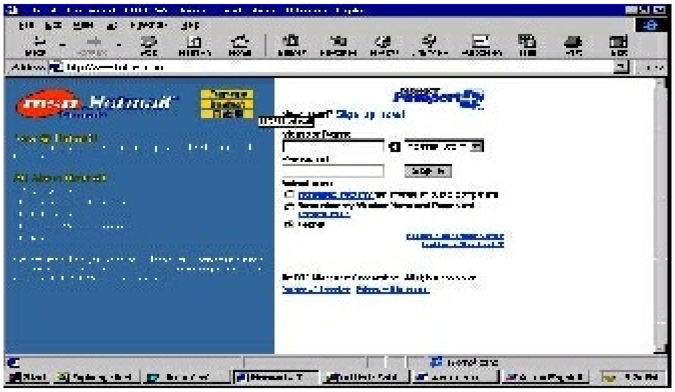
These are many services and tools which are out there and some have been for much longer. They are:

- Internet mail
- File Transfer Protocol (FTP)
- Telnet
- Internet relay chat
- Usenet news
- Mailing lists
- Internet talking
- Gopher
- Archie
- Veronica and jughead
- Wide area information service
- Hypertext transfer protocol
- Hypertext markup language

Internet Mail

Electronic mail is the oldest service on the Internet and still the most dominant. It enables one to send information in the form of letters, messages, advertisements, spreadsheets, game programs, binary files across the net to one or more Internet addresses.

E-mail on the Internet is inexpensive, volume-independent and distance-independent. As an Internet user, you can send and receive messages from anyone else on the Internet. Indeed, this service of Internet mail is so important that, when Internet professionals talk about mail you can always assume they mean electronic mail or email. When Internet professionals need to refer to regular post office mail, they will do so explicitly. Such mail is often referred to as snail mail, as it takes much longer to arrive than Internet mail.



The popular email service is hotmail service by Microsoft.

File Transfer Protocol (FTP)

Ftp is part of the TCP/IP protocol suite. It is a protocol or set of rules, which enables files to be transferred between computers. Ftp works on the client/server principle. A client program enables the user to interact with a server in order to access information and services on the server computer. Files that can be transferred are stored on computers called FTP servers. To access these files, an FTP client program is used. This is an interface that allows the user to locate the file(s) to be transferred and initiate the transfer process.

Anonymous ftp allows a user to access a wealth of publicly available information. No special account or password is needed. There are a wide variety of files that are publicly available through anonymous ftp. They are:

- Shareware: software that you can use free for a trial period but then pay a fee for the licensed version.
- Freeware: completely free software, for example fonts, clipart and games.
- Upgrades and patches: upgrades to amend software and fixes for software problems available either free or against charges.
- Documents: examples include research papers, articles and Internet documentation.

Files on FTP servers are often compressed. Compression decreases file size and this enables more files to be stored on the server and makes file transfer times shorter. In order to use a compressed file the user needs to decompress it using appropriate software. It is a good idea to have current virus checking software on the computer before files are transferred on it.

WS-FTP32 LE is a top rated and very popular FTP program from John Junod. It is given away free to certain non-commercial users.

Telnet

Telnet is a protocol, or set of rules, that enables one computer to connect to another computer. This process is also referred to as remote login. The user’s computer, which initiates the connect icon, is referred to as the local computer and the machine being connected to, which accepts the connection, is referred to as the remote or host computer.

Once connected, the user computer emulates the remote computer. When the user types in commands, they are executed on the remote computer. The users monitor displays what is taking place on the remote computer during the telnet session

Internet Relay Chat (IRC)

IRC works because a series of IRC servers band together in a network to share channels of communication, like communicating with someone or a group on a single radio frequency. If you connect to one server in such a network, you have access to all the channels and all the users connected to any of the servers on that network.

There's have been chatting on the internet since Unix users were able to page each other using the talk username @ address command. Unlike e-mail, chatting takes place live and is called as real time, meaning both people participating at the same time. Chat is synchronous (happening for all participants at the same time), and e-mail is asynchronous (taking place at different times).

Chat protocol permitted many people to converse with each at once. Finally IRC (Internet relay chat) provide for multiple channels where completely separate conversations, all potentially many-to-many become available to anyone on the Internet. The IRC protocol remains the underlying basic for other forms of real-time communication (such as voice or video conferencing). The standard chat interface, with a big dialog window, a narrow list of participants and a command-line at the bottom for typing your responses, continues to be used in many real-time collaboration tools.

Usenet News

Usenet news is a worldwide replicated bulletin board network with tens of thousands of topics that individual around the world discuss constantly. You will find that it is an unparalleled resource for solving technical problems, especially computer and computer networking problems. For any problem you face, you can be assured that someone has probably already faced that problem and found a solution to it. Many progressive companies also provide technical support in newsgroup.

Internet newsgroups are not limited to technical subjects. You will find newsgroups on topics ranging form boat building to politics. The subjects of newsgroups are only as limited as the interests and imaginations of the individuals on the Internet.

Mailing Lists

The Usenet group is open to all, but if the interest of individual is confined to a smaller domain, a mailing list may be used. Discussion groups or announcements of a specific nature generally use mailing lists. Usually servers allow more and more users to enlist themselves in the mailing lists by sending an e-mail message. A discussion group of members restricted to only subscribers as per the mailing list receive messages from the server as soon as someone has sent one. Normally there is no charge for using a mailing list.

INTERNET TALKING

This Internet live audio/video service allows a users computer to connect to other users computer on the Internet. The messages are exchanged in real-time by these users as soon as they are typed by any of them. A program executing in the background called the talk domain handles the actual communication service. This program should be compatible between users desiring to engage in Internet talk. Once the connection is made, the talk domain divides each user screen into two halves by drawing a horizontal line in the middle. The local users keyboard strokes are captured in the upper half, while the typed text of the remote user is displayed in the lower half of the screen. If there are more than two users in the talk mode, the y talk program divides each user screen into as many partitions as the number of users. Netscape's cooltalk is one of the better known packages of this service.

Similarly, video exchange can also be conducted in real-time over the Internet. Software package include cinecom and vdo phone.

Gopher

Gopher is a protocol designed to search, retrieve and display documents from remote sites on the Internet. It accomplishes this using the client/server model of users running client software on their local machines that provide an interface that interacts with remote servers or computers that have information of their interest. In addition to document display and document retrieval, it is possible to initiate on-line connections with other systems via gopher. Information accessible via gopher is stored on many computers all over the Internet. These computers are called gopher servers.

Users interact with gopher via a hierarchy of menus and can use full-text searching capabilities of gopher to identify desired documents. Once an appropriate item is selected, gopher retrieves it from wherever on the network it resides and (if it is text) displays it. The users may feel as if all the information available to gopher resides on their local computer, when in fact, gopher is interacting with a large number of independently owned and operated computers around the world. Gopher client software exists for most computer platforms.

Archie

These are thousands of anonymous ftp servers around the world offering more files than you can imagine. The role of Archie is to make the whole system manageable by helping you find what you need. There are a number of Archie servers around the net, each of which consists a database of most of the files that are publicly available via anonymous ftp.

Suppose you want a particular file – for instance, a program but you don't know which anonymous ftp server has the file. You use an Archie client to convert to an Archie server. You can have your client ask the server to search for files that have the same name as the program you want.

After a short wait, the server will send back a list of addresses of some of the Internet sites that have files with that name. Once you know where to look, it is a simple matter to use ftp to download the file. The term Archie was chosen to express the idea of an archive server.

Veronica And Jughead

Like the web, Gopherspace is large and full of menu items than you could ever find on your own. To help you find things in Gopherspace you can use veronica: a tool that keeps track of an enormous number of gopher menu items from all over the net. You can use Veronica to perform a search and look for all the menu items in gopherspace continuing certain keywords. A related tool, Jughead does the same thing for a specific group of gopher menus: say, all the menus at a particular university.

After Veronica or Jughead finishes searching, you will be presented with a new menu containing the names of whatever items were found. To access one of these items, all you need to do o select it, and your gopher client will connect you to the appropriate gopher server automatically. The results of a typical Veronica search will be items from around the net, but you won't need to know any of the details: your client will take care of everything for you.

Wide Area Information Service (WAIS)

WAIS is an Internet search tool that is based on a certain protocol. It works on the client/server principle. A WAIS client program enables the user computer to contact a WAIS server, submit a search query and receive a response to that query.

WAIS has the capability of simultaneously searching more than one database. After the search phrase has been typed into the client interface, the user can then choose which databases should be used to complete the search. Depending on the WAIS client software being used, this may be a matter of using a mouse to select database names displayed on a screen, or of typing in the database names using the keyboard. It is very important to know that WAIS indirectly searches the database. The database itself is not being searched for the requested search phase. Rather, an index for the database is searched. The index is created by people, and can contain all, or a number of words in all of the items contained in the database. Once the search has been executed, all items containing the words appearing in the search phrase will be returned to the user, provided that the words in the search phrase appear in the indexes of the selected databases.

Hypertext Transfer Protocol (HTTP)

HTTP is a set of rules, or protocol, that governs the transfer of hypertext between two or more computers. The World Wide Web encompasses the universe of information that is available via HTTP.

HTTP is based on the client/server principle. HTTP allows computer A (the client) to establish a connection with computer B (the server) and make a request. The server accepts the connection initiated by the client and sends back a response. An HTTP request identifies the resource that the client is interested in and tells the server what action to take on the resource.

When a user selects a hypertext link, the client program on their computer uses HTTP to contact the server, identifies a resource and asks the server to respond with an action. The server accepts the request and then uses HTTP to respond to or perform the action.

Hypertext Markup Language (HTML)

HTML is used to create static web pages. HTML is made up of various commands known as tags. With the help of these tags you can insert and format text material, images, sound/video, tables, forms, frames, etc.

Html is not a flexible language as it can create only static pages. So to make a complete web site you have to use other languages, scripts and packages like SGML, XML, JavaScripts, Java, ASP, etc.

CASE STUDY

Web Presence

Internet is a relatively new medium, unlike any other medium. It's a very unique combination of the print, audio and video media – a fusion of the more traditional newspaper, billboard, magazine, radio, telephone and video. Companies worldwide are struggling with how best to harness the power it offers. Experimenting with websites is one way they are trying to achieve this.

Over the past few years, however, companies have started understanding it and discovering it's actual potential: not only as a source of information, but as a business tool. Countless organizations are exploring how they can best use the Internet, in particular the World Wide Web (WWW), for business applications.

Why to go for a website?

- As the Web has grown to an enormous size, it has also become a vast repository for information on just about any topic under the sun. For example, you can find out which baby car seat is rated highest, find a prime vacation spot, find a fan club, or even find an attorney specializing in patents.
- For companies and organizations, the Web is an effective, interactive means of advertising products and services while providing essential contact information. By using the Web, service-oriented organizations can effectively communicate with customers, give the impression that they're technologically with it, and above all let their constituents know that they're keeping up with (or surpassing!) the competition.
- As an advertising tool, the Web is an effective way to provide information. Some Websites merely list the company's products, while others actually let potential customers test their products-interactive technology at it's best! For example, at some Websites you can send online greeting cards to your friends and family. Visitors select an online card, fill in some information and then send the card with a click of the mouse (Of course the recipient has to be connected to the Internet).
- As a contact and information resource, the web provides companies, organizations and individuals with an easy way to request or submit information. For example, most Websites provide e-mail links and online forms.
- Individuals are using the Web to provide information about themselves-as in personal home pages or resumes. Personal home pages often include information about hobbies and interests or the latest photos of the family. The Web helps people stay in touch with a large number of people. And, Web page resumes are quickly becoming a means of reaching potential employers. In this sense, the Web serves as a worldwide employment bulletin board.
- A carefully planned Internet presence is the equivalent of opening a new branch that anyone in the world – potential business partners or potential customers – can have access to in a matter of minutes.
- For many businesses, creating an online presence is becoming as necessary as having a telephone. Not having it translates to a loss of customers, dealers, partners, revenue etc.
- Jumping onto the Internet is a full-fledged marketing exercise in itself. Putting up a website is the virtual equivalent of starting a new office simultaneously all over the world and needs to be treated as such. The impression created in the minds of potential customers and partners will depend on the face presented by a website to the world.

Publishing on the Internet

The Web – and, by extension, HTML – is invading a significant part of our lives. At work, the Web serves as an advertising medium, communication tool and even as a message centre. At home, the web has become integral part of our offices, television sets and homework time. Throughout the world, companies, individuals and organizations are providing, retrieving and publishing information with the help of HTML. Whether a Web page consists of only text or also includes intricate graphics, elaborate animations and sophisticated formatting, underlying it is HTML.

Publishing on the Web

The Web has helped revolutionize the publishing industry, making it possible to easily and quickly publish valuable research, lengthy documents and a variety of other materials that probably would never have been circulated without the ease and low cost of Web-based publishing.

Schools and universities use the Web to publish course descriptions, materials, syllabi and assignments. In this capacity, the Web provides the information and becomes a tool in itself as students learn to use it effectively. Given a Web page full of links, images and information, children and adults alike gravitate to the information they need and learn the ins and outs of the Web as they search.

Finally, many scientific journals – in which up-to-date information is key - are published only or primarily on the Web. Researchers can now prepare articles using HTML and then easily publish the information directly on the Web, making it instantly available to the entire world without the several-month lag of getting published through traditional means. The downside, though, is that the critical peer review process can be bypassed. On the Web, as elsewhere, check the reliability of your sources.

FACTS OF THE CASE

This is a real life case. This case is of a garment export company named as Ranjeet Company.

Ranjeet Company deals in the business of garments. They have a turnover of US $10 million per year from India and Nepal, primarily in apparels for ladies, men and children wear both in woven and knits. Their major business is focused in USA. though they have clients in other countries like South Africa, Australia, Canada and Mexico. Now Ranjeet Company wants to create a website of it's own in order to make itself available on the Internet. This task is assigned to a Web analyst Mr Y who solves this case by making the website for Ranjeet Company.

SOLUTION FOR THE CASE

The step-by-step approach to this case is shown below. It starts with the business analysis of the company's requirement leading to the production of the website. For the sake of simplicity we take only one page in the website which is a HTML page with a small java script.

BUSINESS ANALYSIS

Companies that they are representing :

1. In USA they are representing :
   - Gotcha Co.
   - Robert Stock
   - Kimono
   - Oakhill
   - Urban Outfitters
   - Pacific Sunwear
   - Rusty
   - O'Neill
   - East India Home Furnishing Inc.
2. In South Africa they are representing:
   - Meltz success for their buying of arts, jet, edgars saleshouse and Smiley's ladieswear, scarves and accessories.
   - Menswear: Pepe, Mossimo and Guess for South Africa.
   - Vanilla house for home furnishing / furniture (iron / wood) and accessories.
3. In Australia they are representing:
   - Orientique for ladies high fashion dresses and Surfwear for men.
4. In Mexico they are representing:
   - Dorians

Their product line

1. Ladies apparels: knits / wovens.
2. Menswear: knits / wovens.
3. Childrenwear: knits / wovens
4. Giftware /accessories: includes picture frames, decorative accessories, wooden handicrafts.
5. Houseware: includes home storage, cupboards, iron and wood furniture.
6. Hometextile: includes pillow cases, decorative pillows, bedspreads, comforters, bedpillows, bolsters, kitchen textiles, bathrugs, tablecovers, curtains, draperies.

   On all of the above items they cater to popular, moderate, better and high end segments.

Need for Ranjeet Company to be on the Internet

- Ranjeet Co. wants to use the Web technology to become popular and to evolve it as a marketing tool for itself.
- Initially, their business approach is to use the web site largely as an electronic billboard.

- Ranjeet Co. wants to use the Internet as a media to reach out to people around the world with information about their line of business.
- Later sometime they even want to do net-based business i.e. e-commerce. This is because, for corporate India, e-commerce and net-based business is still largely uncharted territory.
- Ranjeet Co. is seeing e-commerce as a strategic tool to gain competitive advantage.

HTML DOCUMENT LIFE CYCLE

HTML

The evolution of HTML involved more than enough changes to the tags and attributes. You'll see that its variety of uses and resulting popularity have changed the nature of HTML from a functional information resource to a marketing tool. HTML did not evolve as an entity on it's own; it took the efforts of many people to bring the technology to what it is today.

Although the concept of hypertext is hardly new – Vaneever Bush originated the term, if not the concept, in the late 1940s – the technology to implement it is a recent development. Additionally, merging the network and hypertext to provide linked information from a distributed set of computers was not practical until only a few years ago.

Physicists at CERN (Centre Europeen pour la Recherche Nucleaire), a European particle physics laboratory, needed an easy way to share information over their network. In 1980, Tim Berners-Lee developed the initial program that allowed pages to links to one another.

The Components of HTML

HTML documents are essentially plain text files. They contain no images, no sounds, videos and no animations; however, they can include "pointers," or links, to these other file types, which is how Web pages end up looking as if they contain non-text elements.

HTML itself is a system of codes made up of tags and attributes that serve to identify parts and characteristics of HTML documents. Some tags provide document structure; others reference while some other files. Attributes provide additional information within tags. HTML tags identify logical document parts, i.e., the major structural components in documents such as headings, lists and paragraphs. These structural components are part of the HTML document. Exactly how structural components appear on your computer screen depends on the browser.

Some tags work in conjunction with attributes, which provide additional information about an element, such as how elements should align (left, center, or right), which other file should be accessed, or even the colour of an element.

Recent HTML developments include Cascading Style Sheets, which you can use to specify text formatting for logical document parts. The only real disadvantage to using Style Sheets is that older browsers do not support them; they simply disregard them.

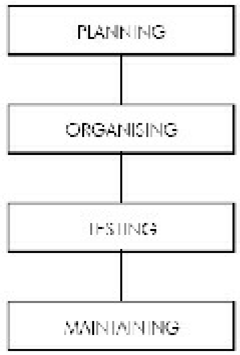
The World Wide Web Consortium (W3C) was founded in 1994 at the Massachusetts Institute of Technology (MIT) to oversee the development of Web standards, including the HTML standard. This consortium defines and publishes HTML standards, the tags and attributes within HTML documents. The HTML standard is an open standard, meaning that any browser developer – and everyone else – has complete access to the HTML specification. Microsoft and Netscape, however, have introduced a variety of extensions to HTML that enhance design and layout control. These 'improvements' have taken HTML from a practical, information-based means of communication to a marketing tool filled with effects designed to dazzle web page visitors.

HTML Document Life Cycle

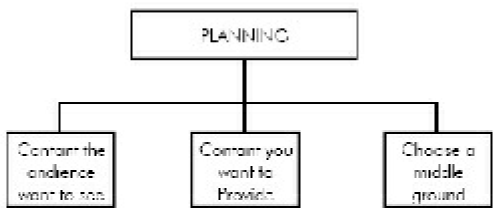
The life cycle of an HTML document includes developing, publishing, testing and maintaining it – whether its ultimate home is on an Intranet, on the Internet, in a kiosk, or in a help file.

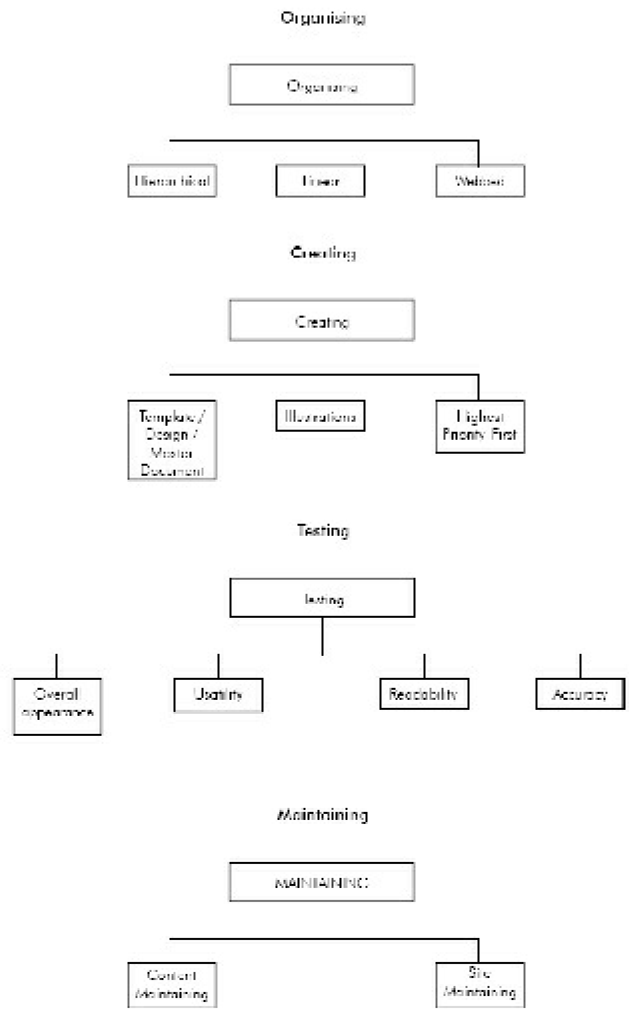
The HTML Document Development Process

PLANNING THE SITE



Planning Phese





Need for Planning

HTML is focussed on making information available easily. The World Wide Web and corporate Intranets were primarily used to provide information to those who needed it. In this capacity, HTML authoring was visitor centered – i.e., authors focussed on determining what their audience wanted and then provided that information.

However, as HTML and other Web technologies became popular, they evolved into a marketing tool for millions of companies, organizations and individuals worldwide. Rather than strictly providing information, the purpose of many Websites is now to tell visitors what the company wants them to know, to persuade them to purchase a product or service and to keep them coming back for more. Therefore, before we start producing HTML, we need to do some planning. In particular, we need to determine what information our visitors want and what we want to provide.

Requirements of Ranjeet Company:

- Domain name registration.
- The site should be easy to follow.
- The visitors should have the flexibility to go from one page of the site to any other page.
- The name of the company should appear on every page.
- The scanned images should be of good quality.
- The images should take less time to be download.
- The site should be dynamic in nature.
- It should have a page on the profile of their company.

- There should be a query form through which the user can ask their queries. This form should be submitted to their e-mail account.
- Upload their website to our server.
- Maintaining the site.

What do the Visitors want ?

When the visitors visit a website, they usually have a reason for going there. Although they often stumble onto a site that interests them while they are browsing, they normally have something specific in mind when they start.

They might want general information about the company, their products and services. Keeping this in mind Mr Y has included the company profile. Web site also includes various samples of men's wear, women wear, children wear and furniture. The visitor may like to see the product range of the company. Visitors are interested in knowing what models were available, their cost and their reliability and safety records. This site gives the user the flexibility to browse one sample after the other and even go to the previous seen samples.

They also wanted to be able to request brochures and locate local dealership. For this, Mr Y provided the site with a feedback form, which the visitor can fill and send online.

What do I want to provide?

Ideally the website will provide all the information that the visitor wants. Planning was that the site would contain information about the company, products and services suitable for use on a website.

The planned list about the website:

- The site will contain the company information and their contact information.
- There will be no mention about the corporate mission statement and the company’s goal.
- There will be samples of their products in the form of images.
- The visitor can even send an online filled up form regarding the product(s) he is interested in.
- The product specifications will not be included on the site.
- The visitor can even request for the company or product literature.
- This site doesn’t give any information about the company’s achievements or company’s sale as the person may not be interested in this.

After the planning was over, some consultation was done with the M D of the company. Mr Y showed him the planned list about the website. The contents to be shown on the website were finalized. They decided to classify the items common to both the visitor's and company’s requirements.

DESIGNING THE SITE

After you decide what information to include in your site, you need to determine how you will arrange individual HTML documents. Taking the time to organize the information carefully is often the difference between having frequent visitors to your site and having none at all. How often do you return to a site that’s not well organized? If you can’t find what you need easily and quickly, you have no reason to go there and the same will be true for visitors to your site.

There are three types of organizations at your disposal:

- Hierarchical
- Linear
- Webbed

You can use each type individually or combine them as needed.

Hierarchical Organization

When you organize information in a hierarchical structure, you present a first group of equally important topics, followed by another group of equally important topics, and so on. This is similar to an organizational chart. The hierarchy starts with top officials, then shows the managers who work for them, the employees who work for these managers, and so on.

The same can be done for a website. You can provide several main points and under each point, you can include subpoints. If you choose hierarchical organization, remember to keep it simple. Visitors to your site will dig through two or three levels of information, but after that they are likely to give up.

Linear Organization

When you organize information in a linear structure, you impose a particular order on it. Instructions and procedures are examples of this type of organization. If you’ve ever used a Microsoft Wizard, you’ve seen linear organization in action. You start the Wizard and then you proceed in a linear fashion from one screen to the next until you click finish. You can back up a step or two if necessary, but if you don’t complete all the steps, you terminate the procedure.

When visitors to your site are working through pages that are organized in a linear fashion, they can't roam to other pages. Therefore, be sure the linear process is essential to the task at hand. Keep the linear sequence as short as possible so that visitors focus on the process and complete it successfully.

Webbed Organization

Webbed organization is a fairly new type of organization that has evolved with online technology and provides visitors with multiple, unorganized paths to resources at a site. A visitor can link from one web page to many other pages at the same website or at another website.

Provide information on each page that helps readers orient themselves. For example, include a running footer or company logo (keep it small) on each page. Provide a link to your home page on all pages. If you do so, visitors can easily return to a familiar page.

Organizing Ranjeet Company's website

The information on the website was the combination of all the three types of organization technique i.e., hierarchical, linear and webbed.

Hierarchical organization was taken help of in order to accommodate several main topics and sub-topics. Linear organization was included to have a specific order in case of showing the garment samples.

DEVELOPING THE SITE

After you've adequately planned your HTML documents, deciding which information to include and how to organize it, you're ready to start creating HTML documents. Much of the rest of this exercise is about how to create HTML documents, including which software to use, how to use tags, how to add links and images, and how to include more advanced effects such as video, sound, frames, JavaScript, and applets.

Software Requirements

- HTML Editors: HTML document can be created on any text editor. Using a word-processing program such as Word, WordPerfect, or even WordPad to create HTML documents introduces extra formatting and control characters, which will cause problems. Html requires Plain Text with no formatting at all.

  Mr Y used notepad to create html documents.

- Web Browsers: If you've ever surfed the Web, you've used a Web browser to view HTML documents. The most common browsers are Netscape Navigator and Microsoft Internet Explorer, although a variety of browsers are available for virtually all computer platforms, online services and Internet service providers.

  Mr Y used Netscape Navigator to run the site.

Contents of Ranjeet Company's website

- Home page: When the site is seen on the Internet, the visitor first sees a page containing a shining star and the company name written on it. This page has a Java script running which after 10 seconds automatically brings the home page on the screen. The home page is divided into 3 frames left, top and bottom. Left frame consists of links in the form of an image map. The top frame consists of the name of the company. The bottom frame is blank. On all the pages a Java script will run which will show scrolling text (about Ranjeet Company) on the status bar.

  From the links the visitor can either go to:

  (i) Company profile

  (ii) Women wear

  (iii) Men's Wear

  (iv) Children wear

  (v) Furniture

  (vi) Online query form

- Company profile: This page contains the information about the Ranjeet Company.
- Women wear: This page shows the women garment samples in series.
- Men's Wear: This page shows the men garment samples in series.
- Children Wear: This page shows the children garment samples in series.
- Furniture: This page shows the furniture designs which are made by the company.
- Online query form: The visitor can send query form to Ranjeet Company.

DOMAIN NAME REGISTRATION

What does Internic Software do?

Internic Software is a business name of Internic Technology Pvt. Ltd ACN 079 268 714. Internic software is a domain name broker, which provides domain name registration services. Internic software is not Network Solutions Inc or InterNIC which operates from www.InterNIC.net (which is the principal domain name registration authority for, amongst others, .com, .org, .net.). Internic software is NOT associated, affiliated with or sponsored by "www.InterNIC.net" or Network Solutions Inc. This web site does NOT provide direct registration with InterNIC; this web site provides a simple and clean method of obtaining registration of a domain name and attracts a brokerage fee in addition to the fees charged by InterNIC for registration. Of course, customer could directly register at www.InterNIC.net but it takes all the hassle out of the domain name registration puzzle.

Registering a domain name with Internic software will cost US $220. This includes the US $70 fee payable to the official registrar Network Solutions Inc. After two years, customer will be billed US $35 by Network Solutions Inc. to renew his registration.

What is required to register a domain name?

Every domain requires that you set up your DNS before applying for your domain name. To set up a DNS you have to make entries for your new domain on two separate machines connected to the Internet. These two machines are called Domain Name Servers, and are referred to as Primary DNS and Secondary DNS.

Most people don't have their own DNS but just want to reserve a name for future use. If you just want to reserve a domain name, then you may have a problem. One option is to contact a local service provider and start paying monthly fees even though you are not using the name.

Another option, without additional charge, is that Internic Software will set up DNS for your domain(s) on its machines. This DNS setup up is temporary and can NOT be used for website hosting. You can change your DNS at any time by simply modifying your domain name information. If you want to use your own DNS, simply fill out the DNS information on our secure online order form. This information is used when your application is submitted.

If you just want to secure your domain name (so that no one else can take it), we will set up your DNS so that your application will be accepted. Just get the name for now and then transfer it over when you're ready to use it.

Domain name registration

The customer has to pay a fees of US $70 to INTERNIC. After two years, the customer will be billed by the relevant registry authority a fee of thirty-five U S Dollars (US $35) per year, per domain name, to renew their existing registration. Refunds payments must be made in advance. All payments are NON-REFUNDABLE. The whole process may take upto 15 days.

Before completing the Registration Agreement, check to see if the domain name has already been registered by accessing their database search.

Internic new registrations form:

FEE: $70 for first 2 years - $35 annual fee thereafter

Enter the following:

Domain Name: (example.com is a valid domain name but http://www.example.com is not a domain name, it is a uniform resource locator (URL used by web browsers to find documents and resources) www.example.com is not a domain name, www is the name of one computer in the example.com domain.)

Your e-mail Address:

Organization (Registrant) Information

Organization Name:

Organization Address:

City, State & Zip:

Country:

Comments (required only if registering a .EDU domain or when requested by Network solutions):

Web Servers

For uploading the site, we always need a web server i.e., server space to store our site. Mr Y had taken a 20 mega bytes server space in USA through an organization in India. The cost was Rs 500 per mega byte. So the total cost for the 20 mega byte slot was Rs 10,000.

A web server's main function is to distribute HTML documents on request. When a visitor accesses your site, the web server finds the specific file and serves it to the computer requesting it.

Web servers and by necessity clients-all speak a common 'language' called HTTP, which stands for Hypertext Transfer Protocol. Whereas computers on the Internet speak TCP/IP, which provides the communication foundation between computers, HTTP is the language that web servers and web browsers use to communicate. And, yes, the TCP/IP protocol must be in place for the HTTP communication to occur between the server and browser.

When a web browser connects to a web server to retrieve a page, the browser connects, retrieves the page and then disconnects. After the visitor selects a link, the browser connects to the server again, retrieves the next page and then disconnects. This process of connecting, transferring information and disconnecting is different from remote logon protocols (such as Telnet) or file transfer protocols (FTP); with those protocols, the established connection remains open even when idle.

In addition to serving files, servers also perform other functions that let you tailor your web pages. For example, servers process forms by taking the data that a visitor submits and forwarding it to you via e-mail or saving it in a database that processes the information as you specify.

Servers also run programs to support the website. They can maintain a counter to track the number of times a specific web page has been accessed, and they can run a server-side image map, which allows a single image to be linked to multiple files, depending on the part of image the visitor clicks.

In general, you can access a server in three ways: through your ISP or through your corporate IS department or by installing and running your own server.

Uploading the Site

Mr Y used FTP (File Transfer Protocol) software to upload the site. The FTP software window is divided into two parts. The first part shows the directories and files of computer. The second part shows the directories and files of server space. Through FTP software the files transferred can be from our side to server side and vice versa and it, acts as a simple file manager for computer and server. It can delete a file, rename a file, change a directory, etc. So Mr Y transferred all the files (relating to Ranjeet co. site) to the server side.

The home page will also have to be renamed to index.html at the server side. This is because the servers all over the world take the home page as index.html in order to follow a convention. Rest all files are connected to the home page through links provided on it.

There were total of 4 html files and 2 image files uploaded on the server for Ranjeet Co. website.

Code for the Website

For the sake of simplicity the site is taken as consisting of a single HTML page. This page is a frame consisting of three frames. The files displayed in these frames are map.htm, ash6.htm and ash7.htm. Map.htm consists of an image map, map.jpg. Ash6.htm also contains a small java script which scrolls the message “Ranjeet Co. specializes in innovative and exclusive manufacturing of readymades, accessories and handicrafts.” in the status bar.

HOME PAGE

- index.html:

```
<html>
<head>
<title>”RANJEET CO.”</title>
</head>
<frameset cols =”30%,*” noresize border=”0" marginwidth=”0" marginheight=”0">
<frame name=”left” src=”map.htm “ scrolling=”no”>
<frameset rows=”35%, *” noresize border=”0" marginwidth=”0" marginheight=”0">
<frame name=”top” src= “ash6.htm” scrolling=”no”>
<frame name=”bottom” src=”ash7.htm” scrolling=”yes”>
</frameset>
</frameset>
</html>
```

- map.htm:

```
<!DOCTYPE HTML PUBLIC “-//W3C//DTD HTML 3.2//EN”>
<HTML><HEAD>
<TITLE>IMGMAP&gt;</TITLE>
<META NAME=”GENERATOR” CONTENT=”Mozilla/3.0Gold (Win95; I) [Netscape]”>
</HEAD>
<BODY BGCOLOR=”#000000">
<P><MAP NAME=”sac”>
<AREA SHAPE=”rect” COORDS=”15,90,77,112" HREF=”wframe.htm” target=”_blank”>
<AREA SHAPE=”rect” COORDS=”41,124,95,139" HREF=”mframe.htm” target=”_blank”>
<AREA SHAPE=”rect” COORDS=”6,150,60,180" HREF=”cframe.htm” target=”_blank”>
<AREA SHAPE=”rect” COORDS=”79,149,134,165" HREF=”fframe.htm” target=”_blank”>
<AREA SHAPE=”rect” COORDS=”67,180,122,199" HREF=”profile.htm” target=”_blank”>
<AREA SHAPE=”rect” COORDS=”53,210,135,239" HREF=”query.htm” target=”_blank”>
</MAP>
<IMG USEMAP=”#sac” SRC=”images/map.jpg” HEIGHT=300 WIDTH=150 border=”0">
```

```
</P>
</BODY>
</HTML>
```

- ash6.htm:

```
<HTML>
<HEAD>
<TITLE>Ranjeet Co.</TITLE>
<SCRIPT language=”JavaScript”>
<!— hide
var scrtxt=”Ranjeet Co. specializes in innovative and exclusive manufacturing of readymades, accessories and handicrafts.   “;
var lentxt=scrtxt.length;
var width=100;
var pos=1-width;
function scroll()
{
pos++;
var scroller=””;
if (pos==lentxt)
{
pos=1-width;
}
if (pos<0)
{
for (var i=1; i<=Math.abs(pos); i++)
{
scroller=scroller+” “;
}
scroller=scroller+scrtxt.substring(0,width-i+1);
}
else
{
scroller=scroller+scrtxt.substring(pos,width+pos);
}
```

```
window.status = scroller;
setTimeout("scroll()",50);
}
//—>
</SCRIPT>
</HEAD>
<BODY bgcolor="white" onLoad="scroll();return true;">
<center><img src="\images\ranjeet.jpg" height="74" width="250"></center>
</BODY>
</HTML>
```

- ash7.htm:

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 3.2//EN">
<HTML>
<HEAD>
<TITLE>Ranjeet Co.</TITLE>
<META NAME="GENERATOR" CONTENT="Mozilla/3.0Gold (Win95; I) [Netscape]">
</HEAD>
<BODY  bgcolor="white"  >
</BODY>
</HTML>
```

TESTING THE SITE

Before launching any site, testing plays a very important role in it's success afterwards.

Testing an HTML document involves viewing your documents in multiple browsers with a variety of system settings. The purpose is to see how your documents will appear to your visitors, to check the readability and usability and to rule out any layout or formatting problems.

You will want to test for these issues on your local computer before you publish your pages on the World Wide Web or on an Intranet. In doing so, you can get a general idea of what your visitor is likely to see; however, your visitor's browser and computer settings could alter a document's appearance. You can check this out if you view a document using Internet Explorer on a computer with a low-resolution monitor and then look at it using a Netscape browser on a computer with a high-resolution monitor. Web pages are similar to the marketing materials the company uses.

Testing the Site for Overall Appearance:

- The layout and design were aesthetically appealing.
- The pages were properly aligned.
- The contents, text and images are clearly visible.

- Colours were appearing as they should. There were no odd pattern or colour.
- All the pages contained navigation tools.
- The frames were appearing as they were planned.
- All the scripts were running.
- Even if the size of the display window was changed, the site's overall appearance was satisfactory.

Testing the Site for Usability:

- The pages and the images take very less time to get downloaded.
- Mr Y found it very easy to navigate through the site.
- All the links are working.

Testing the Site for Readability:

- The text and images are easily readable.
- Headings, captions, addresses were clearly stated.
- By changing the size of the display window or the colour depth settings, the site runs properly.

Testing the Site for Accuracy:

- The content of the site is correct and up-to-date.
- Headings summarize the content that follows.
- References to figures and illustrations are correct.

Pilot testing the website:

- People were asked to browse the site. They identified the problems and areas for improvement. The site was further modified.

MAINTAINING THE SITE

Before launching a site it's maintenance aspects has to be taken care of. Although maintaining your documents after you create them and throughout their existence on your site is a separate phase in the life cycle of documents, you also need to include maintenance in the planning phase. This is particularly the case if you answer yes to any of the following questions:

- Will more than person be involved in developing the content?
- Will more than one person play an active role in maintaining the site?
- Will your site include more than about 20 HTML documents?
- Will you frequently add or modify a significant numbers of pages – say, more than 20-25 percent of the total number of documents?

Planning for Content Maintenance

If you will be depending on others for content, you need to make arrangements at the outset for how you will obtain updates. Will content providers actually develop and update the Web pages, or will they simply send you new information via e-mail? You need to plan accordingly if they are going to merely send you a publication (for example, the annual report) and expect you to figure out what has changed. Planning now how you will handle content revisions and updates will save you time (and grief) later.

Planning for Site Maintenance

Regardless of whether you or someone else will maintain the site you develop, you need to carefully document the development process and include the following information:

- The site's purpose and goals
- The process whereby you determined content
- Who provides content

Documenting the development process will help those who maintain the site (or fill your position when you leave) to keep everything up-to-date.

Maintaining HTML documents is the process of updating and revising existing pages, adding new pages, and deleting outdated pages. Regularly maintaining HTML documents are essential if you want visitors to keep returning to your site. Also, regular maintenance helps make long-term maintenance less cumbersome.

HTML documents contain two types of information:

- Static
- Dynamic

Static information remains constant. The company logo, most menus and even product descriptions are examples of static information. Dynamic information, on the other hand, must be changed or updated regularly. Prices, schedules, specific or timely information and product lists are examples of dynamic information.

Developing a Plan

Back in the HTML document planning stages, you might have taken a few steps to make maintenance easier. In particular, you might have made update arrangements with content providers. Or, you might have developed some sort of documentation to help focus pages as the content changes. If you took either of these steps, you have a head start.

If you didn't plan adequately for maintenance - for example, if you didn't realize how much content you'd have or how difficult it would be to get updated information from your providers – you can still make maintenance a fairly straightforward process. First, device a maintenance schedule. Set a time every day, every few days, or every few weeks (depending on how frequently the dynamic information changes) to update your documents.

Second, device a maintenance plan. For example, if you know that you'll only be adding tidbits of information every few weeks, you can probably do that without much problem. If you're likely to receive pages and pages of information to add or if you're likely to make significant changes, however, you'll need to determine how to make the additions and changes most effectively. In these cases, hand-coding the information probably isn't the most effective way; conversion software, which does a lot of the coding for you, might be a better idea. In either case, determine how much you'll be changing and decide how best to handle it.

Keeping Up

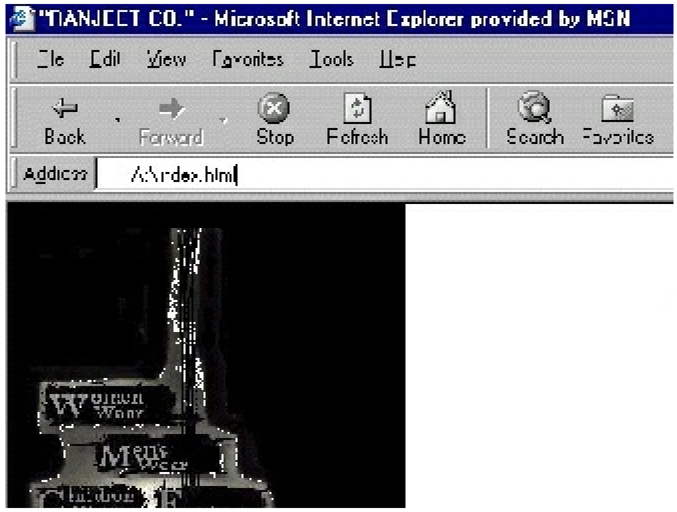
As you're adding, deleting, and updating information in your HTML documents, you'll need to routinely do the following:

- Check for links that don't work or that go to outdated information (also known as **link rot**). As you add and remove information from your site, you'll find that some pages suddenly have no links to them, and other existing links don't go anywhere. Manually browse all your links, and take advantage of link – checking programs on the Web.
- Balance the latest HTML specification capabilities with what visitors' browsers can display. You probably won't want to develop a totally HTML 4 – enhanced document if your visitors' browsers don't support all the version 4 effects.
- Ensure that older pages still look good in new versions of browsers. Often changes in browser software affect how some elements – such as images, tables and forms – are displayed.
- Check older pages for references to outdated information. For example, you might want to update present–tense references to past presidential elections, sports records, or even products, prices and schedules.

OUTPUT

The output is a single HTML page consisting of three frames and an image map as follows.

In this way the case concerning a real life web project is solved. This may not be the way for some but a site cannot be made without a proper planning.



INTRANET

A few years back, people used the word Internet (with a lower case “i”) to mean any small network running based on the same protocols that the big-I. Internet runs on TCP/IP and the other so-called Internet protocols. When the idea of running an enterprises in-house network on Internet protocols began to take hold, the alternative term Intranet came into usage. Lately, we can use the term extranet as well to mean a small, private network connecting securely remote sites over the public Internet.

The advantage, by the way, behind all the type about Intranets, is that tools for browsing Internet and web-style resources are already cheap and plentiful, and most workers have already trained themselves to use some of them. The drawback is that all the old proprietary network systems had their own highly sophisticated tools, and some people will be taking a step back if they go to an all intranet/extranet approach. Therefore an Intranet is just a system for using the Internet utilities on a local network. For example, a company might put scheduling information, employee manuals and even electronic forms on an internal web server. This would allow employees to browse and use this information using a common web browser.

Intranet use Internet technology to deliver an organizations internal information. This includes integration of e-mail, FTP, mail server and web server with the internal applications, the user interface is provided by the web browsers. Of these, web servers are the most visible part of the Intranet since this is where the organizations web pages would be hosted and accessed by the client machines. The objective of an Intranet is to organize each individuals desktop with minimal cost, time and effort to be more productive, cost-efficient, timely and competitive. With an Intranet, access to all information, applications and data can be made available through the same browser. Intranets connect people together with Internet technology, using web servers, web browsers and data warehouses in a single view. Of course, all clients and servers must support the TCP/IP protocol. Though it uses Internet technology, an Intranet does not have to be connected to the Internet. However, moving mail and other information across the Internet to clients and partners might be needed, so an Internet connection may be desirable. The differences between the Internet and Intranets need to be appreciated in order to handle applications properly. Whereas the Internet is always starved of bandwidth, Intranets, even on the slowest LANs with bandwidth of 10Mbps, have no bandwidth issues. Therefore, an application designed for the Intranet may not be able to run on the Internet, while those designed for the Internet may run in a flash on the Intranet. Since the Internet is an open environment, security is a major issue. Intranets, on the other hand, are secured and confined to organizations.

Intranets provide a lot of choice and flexibility by virtue of being developed on open standards and protocols. Existing applications do not have to be rewritten to be compatible to new client-server environments. New versions of word processors, spreadsheets and database programs have built-in Internet capabilities. A web page can be automatically provided from an existing word-processed document by simply saving it as an HTML document. However, policies for using the technology within the organizations are extremely important. The open nature of the Internet however cannot be replicated in an Intranet since company data would be available on it and would need to be handled very cautiously. Security is provided in the Intranet environment through the deployment of protocols such as secure socket layer (ssl), secure electronic transactions (set), and secure time to provide confidentiality data integrity, authentication and digital signatures. Access to internal information systems from outside can be regulated through the installation of firewalls. The departments in an organization, which could benefit by implementing an Intranet, include finance, sales and marketing, manufacturing, R & D, personnel and customer support.

Intranet Services

An Intranet provides Internet services within an organization. The Intranet client is a universal browser using TCP/IP protocol. There may be any number of servers in the origination; they may support any services on any operating system. As long as they support TCP/IP protocol stack, they are part of the Intranet.

An Intranet has to be designed for the specific functionality requirements of an organization. The requirements or services may include the following:

- Mail services
- Audio and video services
- File transfers
- Web services

The enhanced Intranets are characterized as Full Service Intranets. This term is defined by Forester Research as a corporate TCP/IP network which delivers reliable, feature-rich applications that share five core, standards -based services-directory, e-mail, file, print, and network management. The key is to set up an Intranet, which incorporates in its design the concept of the universal browser as the touchstone for a vendor independent implementation based on non-proprietary networking standards. The easier way to start is by providing e-mail services from a standards- based server, i.e. SMTP mail server with client using Netscape Navigator or the Microsoft Internet Explorer browser to retrieve mail, using pop3 protocol, from the mail server. The simplest way for setting up a server is by installing a Unix system, which has built-in free SMTP mail server software. No expensive gateways are required. In fact Unix is available for free as Linux which is complete with SMTP mail server. This is the easiest way to get started and demonstrate the usefulness of an Internet and thus enlist the support of the top management.

The essential components of an Intranet include the following:

- A network
- TCP/IP on servers and clients
- Hardware for hosting intranet services
- Software-mail server and web servers
- Browsers
- Proxy servers

- E-mail remote user agents

Usefulness of Intranet

Mail and web-enabled application on an Intranet help in saving costs which is realized from reductions is printing and distribution costs. But one of the largest benefits is the increased access to information. An Intranet achieves the following in an organization:

- Reduced costs in printing, paper, software distribution, mailing , order processing
- Reduced telephone expenses
- Easier, faster access to technical and marketing information.
- Easier , faster access to remote locations
- Increased access to competitive information
- Latest and up-to-date research base
- Easier access to customers and partners
- Collaborative, group working
- Increased accuracy and timeliness of information
- Just-in-time information

This requires that the management analyze the business problems of the issues that are being addressed through an Intranet. The focus should therefore, be not on technology, but on business. It is the business needs that should drive an Internet. All or some of the above benefits will make a business case for an Intranet. Requirements must, therefore, be studied carefully, and the intranet tailored towards realizing them to provide the organization with the much needed tools for operational efficiency, better twin-around time, better knowledge base, more productivity and competitiveness to survive in the market-pace.

Intranet Implementation

The Intranet is best implemented in a phased manner. Assuming that a network is already in place, the steps essentially revolve around selecting servers and software, the operating system and special tools for content creation. The emphasis should be on creating a system that is amenable to constant change and updating rather than on static documents, because if it were the latter, the users would soon lose interest in accessing information from the corporate Intranet. The existing databases and software applications should also be integrated into the Intranet. This calls for a proper plan to be prepared.

The planning in the form of the scope of services and facilities; mail, websites, department-wise, homepages, personal, administration of the site, layout of pages, connecting with existing databases and applications, dial up access to intranet and connecting with the internet. Then comes the planing of the subnets. If the number of servers and clients is large, there may be many subnets. IP addressing plan should be worked out in detail.

Server hardware platforms and the software that will be used on them for hosting mail and web services need to be finalized. Similarly, for Intranet users, browsers and mail client have to be standardized. The best way to start is to take any existing Intel Desktop system and convert it into a server platform, which may host both, mail and web services. As the Intranet load grows, this could be split into multiple-servers without the users feeling any difference. Web server, mail server, print server, Domain Server (DMS), workflow applications etc. could be implemented on different hardware systems. Choose an operating system from the following popular server operation systems-Unix, Linux, Windows NT, NetWare, Mac OS, OS/2, AS/400. The choice of operating system will determine the software requirements of the web server, mail server etc. It will have a direct bearing on the total cost of Intranet software. Today PC class servers have broken into the erstwhile exclusive domain of RISC servers for web services, by their increased performance, robustness and reliability. While Unix was the operating system on RISC systems, non-Unix platforms are equally aggressive solution now. It should be installed on the server, complete with the TCP/IP suite of protocols. Web server and mail server here need to be configured at the very minimum as Intranet software. DNS services could preferably be implemented from the very beginning. IP addresses and subnet masks must be allocated and all nodes and servers tested for communication. It is better to plan for, and use TCP/IP addresses duly registered with interNIC so that connection to the Internet at a future date avoids address conflicts.

It the Intranet requirements include the users connected on it to share a single Internet dial-up connection on the network, a proxy server is essential. It is the proxy server that dials into the Internet connection and all the nodes access the Internet through it. HTML editors, web-enables office productivity tools would be essential on client machines, which have already been equipped with browsers and e-mail software.

Train the users on mail and web applications. Show them how to use a discussion group, mailing list server, and FTP server. Show them how to convert their existing documents and reports for the Intranet, and make the same available to all. Show them how to create new contents using the office-suites, productivity tools, HTML editors etc. Set up a group of programmers to study the existing database and to web-enabled them for intranet. The web is like a magazine, and content creation is more like web publishing. The magazine is on the web server and is meant for employees of an organization who are on the Intranet. The contents have to be catchy, exciting, easy to access and upto date. Web design and maintenance thus becomes the major issue on an

Intranet. Current intranet technologies suffer from handicaps in that they cannot easily handle problems such as updating or changing expired links in web pages, setting up a directory of users and accessible files, or managing documents and setting version controls for routing. Although vendors including Netscape, IBM, LOTUS, MICROSOFT have plans to release products to handle all these problems, it will be quite some time before these become embedded.

Intranet Administrator

Intranets have generally come to be managed in organizations by managers who have been christened as Intranet administrators.

In the Internet world, the administrator is responsible for the setting up and maintenance of a company's internal or external website. This term and the role borrowed from there, has been given a wider meaning in the Intranet. The webmaster is responsible for the creation and maintenance of Intranet servers and services. He or she maintains the functionality of the intranet services provided, and is responsible for updating the content of the websites, mail directories, integrating with databases, connection with the internet. The administrator has to know the organization's business very well, besides being familiar with the Internet and being thorough with programming languages and network technology. Intranet planning requires that the administrator visualize the present and the future goals of websites, on a wider canvas. Emerging technologies and business models must fascinate him or her. Above all, he or she must be able to work with the organizations Intranet committee since Intranet is expected to change methods of working and change management is not easy. The committee must include representatives from all corporate departments who should articulate their requirements. Since the administrator is required to have many types of skills and since no one person may have them, the greatest ability one look for in administrator is a desire to learn and acquire new skills. In short, the administrator must clearly understand the organization's problems and challenges, develop a cross organizational plan for the intranet, translate it into a technical plan to support the plan and deploy effective support tools on servers and clients to initially provide the desired complement of intranet services, with an eye to the future for full intranet services. The administrator must be equally alive to the concerns of the management and those of the users, providers and developers. As the Intranet grows, the administrator may cease to be just one person. In larger organizations, several people collectively may act as the administrator or as an Intranet administrative team. Distribution of responsibility can ensure uptodate content including websites, directories and database links etc.
The administrator can enable Intranet application to be ready for electronic commerce through the Internet gateway. In this role an Intranet may become an Extranet.

REVISION EXERCISES

1. Give a brief history of Internet?
2. Define the following terms in detail:
   (a) Network
   (b) Client and servers
   (c) Host and terminals
   (d) TCP / IP
   (e) World wide web (WWW)
   (f) IP Address
   (g) Domain name
   (h) Internet service Provider (ISP)
   (i) Internet security
   (j) Net surfing
   (k) Web search engine
3. Explain the protocol used by the browsers and servers to communicate to each other.
4. What is the difference between the various scripting languages like JavaScript, Jscript and VBScript?
5. What is the major drawback of using Java applets in a web site?
6. Browse the Internet and go to the following URLs or sites:
   (a) www.yahoo.com
   (b) www.blackberrys.com
   (c) www.amazon.com
   (d) www.hotmail.com
7. What are the different protocols used on the Intranet and Internet?
8. Break up the following URL into different parts and explain each of them: www.webconnet.com/cgi_bin/form.cgi
9. What are the different web browsers used on the Internet? Explain the Difference between Internet explorer (by Microsoft) and Netscape Communicator (by Netscape) on the basis of their navigational properties.
10. How does Domain name service (DNS) enables Internet clients and hosts to refer

to one another using human-readable names rather than IP addresses?

11. Collect the names of all the Internet Service Providers operating in and around Delhi?
12. What are the hardware and software requirements to navigate the Internet?
13. What are the various services available on the Internet and Intranet? Explain each of them in detail.
14. In simple language explain the difference between Internet and Intranet?
15. What role does Intranet play in any organization?
16. What are the various stages of implementation of Intranet in any organization?
17. How do administrator helps in maintaining a proper Intranet environment in the organization?

Chapter 19: MOBILE COMPUTING

INTRODUCTION

Rapid advances in Communication Technology have been witnessed. The mobile revolution has happened and is happening further. Computers are a fact of life, but their usage by the common man is still limited due to a variety of reasons. The foremost amongst these reasons is the technicalities involved in using computers. Most people are averse to using computers because they feel that they will require specialized training and that even after that they may or may not be capable of using computers.

With the advent of mobile telephony, the acceptance of the mobile has been unprecedented and this acceptance is increasing very rapidly as evidenced by the number of mobile sets being sold throughout the world. In fact ‘mobility‘ is the buzzword in the industry today. Mobility was associated with the mobile salesman who could be contacted anywhere, anytime and anyhow. This concept found widespread acceptance through GSM (Global System for Mobile Communication) in 1991.

This growing acceptance of the mobile by everyone, coupled with rapid technological advancement, led to the natural conclusions that more and more services and information, apart from telephony, could be made available by proper blending. Things like accessing information through e-mail or shopping online through mobile have been targeted and achieved comfortably.

In 1997, four major mobile/ telecommunication companies, viz., Ericsson, Motorola, Phone.com and Nokia, came together and made a forum known as WAP Forum. Even before this, Protocols had been developed for the type of additional services required, separately in Japan and USA. It was felt by the major players in the mobile telephony arena that coming together and evolving a common standard protocol would benefit all by opening the world markets to everyone. The major task/objective before this forum was to provide Internet access from mobile phones. In keeping with this a WAP (Wireless Application Protocol) was developed and agreed upon.

WAP is a communication protocol and application environment for the deployment of information resources, Internet access and telephonic services from mobile devices.

The first WAP phones appeared in the market in 1999. The time for Internet to move from the personal computer to the mobile phone had arrived. But this encountered the various limitations of Mobiles, as stated under:

1. Too much bandwidth is required for normal Internet applications, which is not available in wireless.
2. The web page does not fit into the phone display.

3. The typical keyboard is missing in the mobile.

4. TCP/IP & HTTP are as such not suitable for mobile communication, as they require large overheads as well as a very high processing power on the client device.

5. Whenever information goes through the various elements of the mobile network, a little delay is introduced at every element .The air interface, which is used to transmit data has a limited bandwidth, and together with the accumulated delay, creates a waiting period, called **latency,** which is undesirable. For example a typical HTML page of 20 KB would have a download time of 3 seconds with a 56Kbps modem. This same page on the wireless network would take approximately 17 seconds to download since bandwidth would be 9.6Kbps. (Note with the advent of GPRS this limitation has been by and large addressed)

   Further, an average latency in a wireless network is around 1/2 second but can be as high as 10 seconds. This can cause severe retransmission and subsequent congestion.

6. The mobile device has limited memory and limited processing power.

Keeping in mind the above limitations, it is clear that a completely new protocol is needed to tackle the new scenario for Internet.

THE WAP ARCHITECTURE

The main difference in the architecture, when compared with the Web is the presence of a WAP Gateway for translating between HTTP and WAP. The goal of WAP was to use the web structure in order to provide communication between the mobile devices and the content providers in a more efficient manner than if the web protocols were used.

Refer to the line diagram, and you will notice the following steps that take place in a WAP Communication:

1. The mobile user will enter the URL of a WAP site
2. The phone will convert the URL into a WSP request
3. The phone will send the WSP request to the WAP gateway
4. The WAP gateway converts the WSP request to an HTTP request
5. The WAP gateway sends the HTTP request to the Internet
6. The web/application server creates a WML page
7. The response is sent back to the WAP gateway
8. The WAP gateway converts WML to binary WML

9. The WAP gateway sends the binary WML using WSP

10. The phone converts binary WML to text WML and displays it

Having seen the elements and working of the WAP architecture, let us look at these in a little bit more detail.

1. WAP Device: This is the physical device used to access WAP Content. It need not be a mobile phone and can be PDA also, the only criterion being that it should be WAP compliant.

2. WAP Client: The only requirement for a device to be WAP compliant is that it must implement WAE User Agent, WTA User Agent and the WAP Stack.

   WAE User Agent or Wireless Application Environment User Agent is the micro-browser that enables the display of the content. The compiled WML, WMLScript etc. is received by this browser and is executed or displayed on the screen of the WAP device.

   WTA User Agent or Wireless Telephony Application User Agent executes the compiled files received from the WTA Server. It includes network functionalities such as dialing, answering, location indication services, message management, etc.

   Connecting to the WAP Gateway using WAP protocols is achieved through the implementation of the WAP Stack.

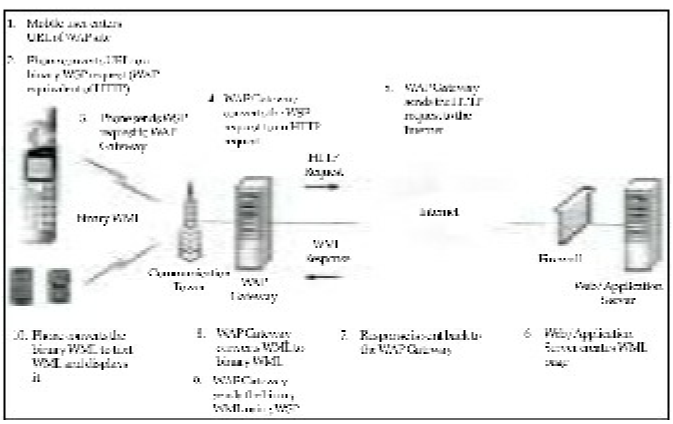


Figure 19.1

3. WAP Gateway: The following steps are executed in a WAP session on one's mobile phone

   - A connection is made between the mobile phone and a WAP gateway
   - The address of the WAP site being requested by you is sent to the gateway from the device's micro-browser
   - The gateway translates this WSP request into an HTTP request and sends it to the server hosting the site

- The origin server sends back the requested information to the gateway through HTTP
- The gateway translates and compresses the information and sends it to the micro-browser in the mobile.

Here are some additional definitions.

Proxy: It is the intermediary element acting both as a client and a server in the network, and is located between the client and the origin server, and normally caches the information received from the origin server. This is used to connect wireless network with the Internet. It contains protocol gateway and encoder/decoder functions. The coder/decoder (CODEC) within the gateway is used to convert WML and WMLScript content for low bandwidth, high latency as the situation demands.

Origin Server: is the Server where the WAP site resides.

Gateway: This is the server or element required to connect two different types of networks. It receives a request directly from the client as if it were the origin server.

WAP INTERNAL STRUCTURE

WAP protocol stack is the set of all layers that form the set of protocols. It has 5 different layers as shown in the Figure below:

Application Layer (WAP)
Session Layer(WSP)
Transaction Layer(WTP)
Security Layer(WTLS)
Transport Layer(WDP)
Bearers(SMS,CSD,USSD,CDMA,CDPD...)

Figure 19.2: WAP Protocol Stack

WAP protocols are compact and lighter than TCP/IP used in the web, which have high overheads and are not effective in high latency and low bandwidth networks.

Wireless Application Environment (WAE)

The Application Layer consists of all the elements related to the development and execution of an application. This means that the Wireless application Environment will allow the application developer to create specific services and formats meant for high latency and low bandwidth devices/networks.

The main components of a WAE are:

- A Markup Language WML

- A Scripting Language WML Script

Wireless Session Layer (WSP)

The Session layer enables applications to share data amongst themselves in an organized manner. This is done through session services protocols, which provide functionalities to connect the client and server by using primitives (messages that a client sends to the server to request a facility). Two types of protocols are mainly used viz. the connection oriented session services and the connectionless session services.

Connection oriented session services operate over the Wireless Transaction Protocol and provide facilities used to transmit reliable data and to manage a session. Connectionless session services operate over the Wireless Transport Layer and provide only non-confirmed services and unconfirmed push from server to client.

Wireless Transaction Layer (WTP)

The transaction layer provides services through the Wireless Transaction Protocol in order to accomplish reliable and non-reliable transactions, which operate over the WDP layer or over the Security layer. Three types of transactions can occur:

a. Reliable requests

b. Unreliable requests

c. Reliable requests with one result message

Wireless Transport Layer Security (WTLS)

Just as concerns of Privacy, Authentication, Data integrity are a matter of grave importance on the web, likewise WAP also provides security through Wireless Transport layer security, which is based on Transport layer security which in turn is based on SSL (Secure Socket Layer used in Web). A WTLS session is initiated between the mobile and the WAP gateway. At the same time a SSL session is initiated between the WAP gateway and the web-server. Encrypted content is sent through this connection from the web server to the gateway, which then translates it and sends it to the mobile phone.

Wireless Datagram Protocol (WDP)

This is the bottommost layer of the WAP Stack and is extremely portable and inter-operable on different mobile networks. It protects the upper layers from the bearer services of the network so that data transmission can be done transparently over the different bearers like SMS, CSD, USSD, CDMA.

The area or the geographic region which has to be covered by a wireless network is divided into sections. Each section is called a cell. That is why wireless networks are also sometimes referred to as Cellular networks. Each cell has an antenna, which is called a Base Station, which communicates with the mobile phones.

These base stations are controlled by a controller, which is in turn attached to a mobile switching centre. Base Station Controller has access to the entire wireless network and, as such, subscribers are able to communicate with normal landlines as well as mobiles. The mobile phone always communicates with the base station, which in turns connects you or informs you of an incoming call. In case you are moving and move out of the base station control, a handing over procedure takes place between the new base station and the old one whose area you are leaving.

WIRELESS MARKUP LANGUAGE (WML)

The Wireless Markup Language is the HTML of WAP browsers and is transmitted via the HTTP protocol. Files can be edited by any text editor (in word processors like Word save as text only) and should have the extension .wml. These files can then be uploaded to your web space provider with an ftp program. Please note that your provider has to allow the retrieval of wml-files in the server settings. The current WML specification can be found at WapForum.org, a short overview on changes from version 1.1 to 1.2 and 1.3 under WML1.3, as well as a Markup Reference and Comparison Chart for all relevant languages.

Here in our examples, we are using SDK (Software Development Toolkit) to run our WAP Programs. We have different simulators used for testing it on different handsets. In this we will be using Nokia Toolkit to run the WAP enabled programs.

Elements

As WML is a language derived from XML, each element has an opening and a closing tag; if no actual content exists, an abbreviation can be used. WML is, therefore, case-sensitive; tags have to be given in lowercase letters.

```
<tag>Content</tag>

<tag/>

<tag attribute=”value1">Content</tag>

<tag attribute=”value”/>
```

Deck

A Deck is best compared to a traditional HTML page and consists of one or more Cards. It is always the complete deck that is loaded to the device; therefore, the deck should be small and contain logically pertaining cards. A Deck has a <wml> Tag at the beginning (and a reciprocal closing </wml> at the end), and contains Meta-Tags and if needed <do>-elements good for all cards of this deck.

Prolog

Every valid WML document must contain a prolog giving the used XML version and WML Document Type Definition (DTD, in this case version 1.2).

```
<?xml version=”1.0"?>
<!DOCTYPE wml PUBLIC “-//WAPFORUM//DTD WML 1.2//EN”
“http://www.wapforum.org/DTD/wml_1.2.xml”>
```

We need to begin with Document Prologue, in which we have to give that we are using xml version=”1.0” and above and in the second line we give the Document type definition so that all the tags and the protocols which are designed byWAPFORUM.org are properly taken care of.

```
<?xml version=”1.0"?>
<!DOCTYPE wml PUBLIC “-//WAPFORUM//DTD WML 1.2//EN”
“http://www.wapforum.org/DTD/wml_1.2.xml”>
```

Meta-Tags

These proliferate information to search engines and are surrounded by a <head> tag. These are located at the head of the file after the prolog and the <wml> tag.

```
<head>
<meta name=”keywords” content=”keyword”/>
<meta name=”description” content=”a description”/>
<meta name=”author” content=”Thomas Ziegler”/>
</head>
```

Comments

Comments are not displayed in the browser.

```
<!—This is a comment—>
```

Files can be saved with the following extensions

Extension	**Description**
.wml	Wireless Markup Language
.wmlc	Compiled Wireless Markup Language

.wmls	Wireless Markup Language Script
.wmlsc	Compiled Wireless Markup Language Script
.wbmp	Wireless Bitmap Language

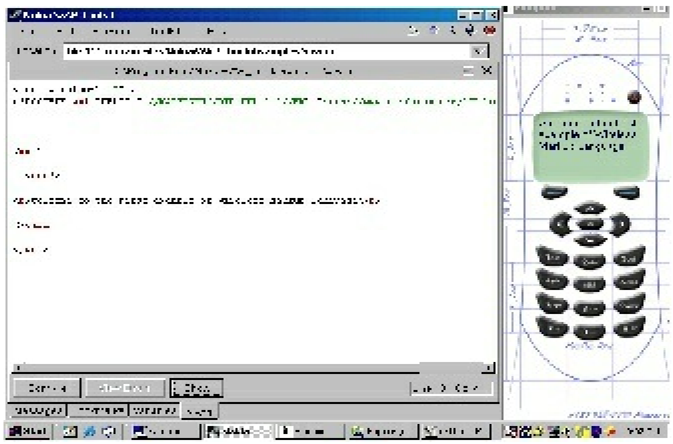
Cards

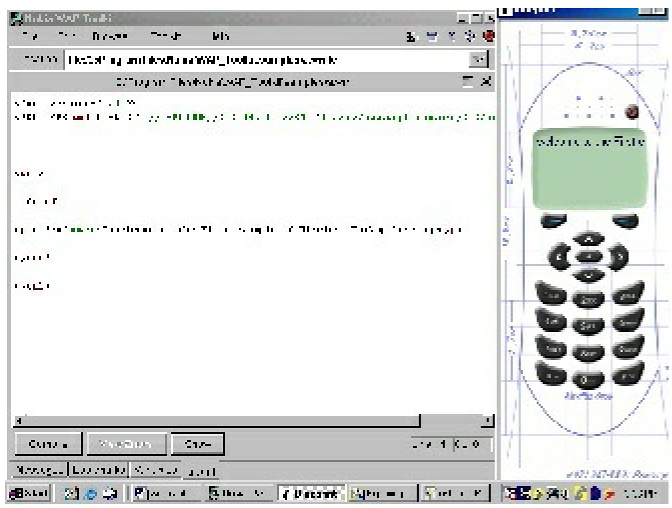
A Card is the part of a Deck where the user navigates. He jumps from one <card> to another - which may reside in the same deck (in the same file) or somewhere else.

```
<card id=”cardid” title=”Card Title”>
<p>
Text on this card
</p>
</card>
```

Card Attributes	
Id	card id, used as jump target (see Links)
Title	A card title

Paragraph Attribute	
Id	Paragraph id
Align	Left/Right/Center
Mode	Wrap/Nowrap





Links

Links may be given in two ways, but the <a> tag is preferred.

<anchor>Go to URL<go href=”url.wml”/></anchor>

Go to card

Go to card

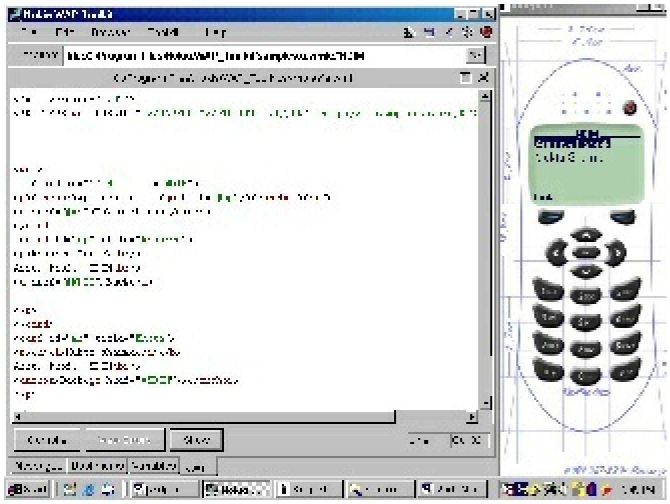
Attributes

Many elements (<a>, <input>, ...) can be attributed with positioning aids (for the order in which a Tab key press traverses them or for a shortcut key directly selecting an element).

<a tabindex=”1" accesskey=”1" href=”#card1"/>

tabindex: order of selection with the tab key

accesskey: key shortcut. In this example we have used <a> tag & <anchor> tag



<a href="URL">

<anchor> tag can't work without tasks (<go> or<prev/>)

Text Masking

As with HTML special characters have to be masked to be displayed correctly.

"	Quotation Mark
'	Apostrophe
&	Ampersand
<	Less than
>	Greater than
	Non-breaking space
	"Soft hyphen", a conditional hyphenation

Formatting

emphasized
emphasized
bold
<i>italic</i>
<u>underlined</u>
<big>big</big>
small

Line Breaks

Tasks

<go href="URL"/>	Used for Forward Navigation
<prev/>	Used for Backward Navigation

<refresh/>	Reloads the current Page
<noop/>	No Operations

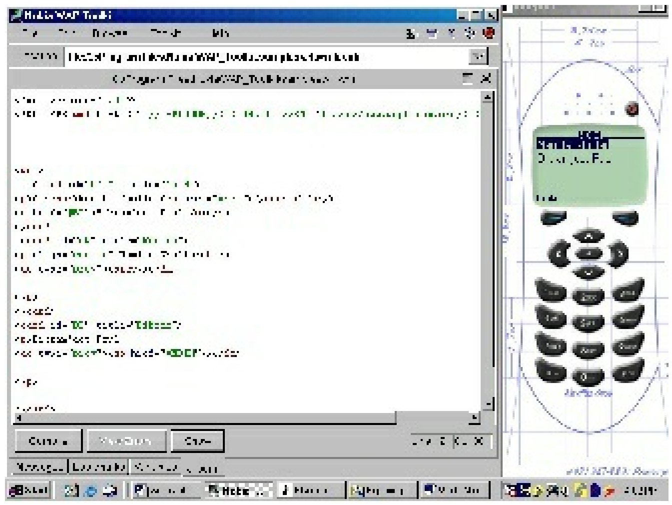
NAVIGATION

Forward Navigation

When you click on a forward button it will open a new card for you.

Backward Navigation

When you click on a back button it will take you to the previous page. Popping the current card from the stack.



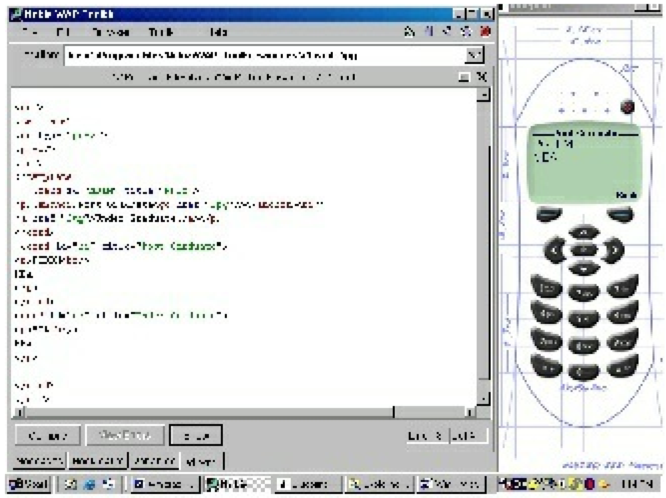
In this example when we are on the card of Namita Khullar and when we click on Back it will pop this page and will take the NDIM card or us to the previous. But, if you are on the BP card and then you click back button it will again open the first card, which is NDIM.

Do

<do> handles Events.

<do> elements on Card level overwrite <do> tags on deck level with the same name, with <noop> a deck level event handler can be disabled locally. On deck level <do> has to be surrounded by <template> and </template>.

label	Describes the element
type	"accept", "prev", "options", “delete”, “help”
name	Name of the event handler



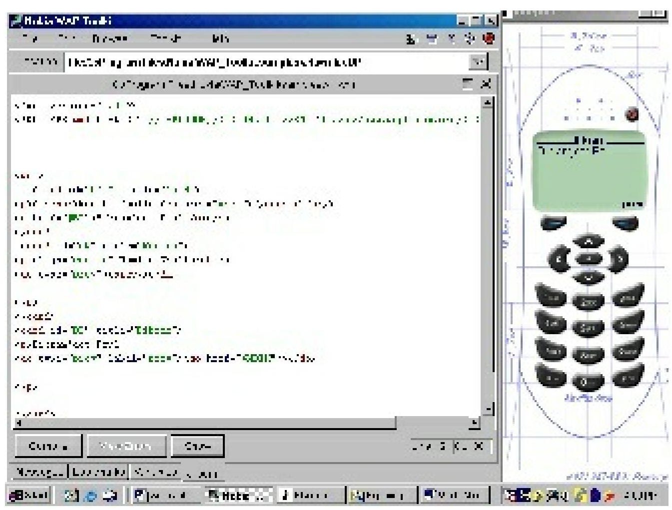
Now suppose we have created 10 cards in a deck and while pressing prev/back button we need to come on the first card. We don't need to key in the command

<do type="prev">

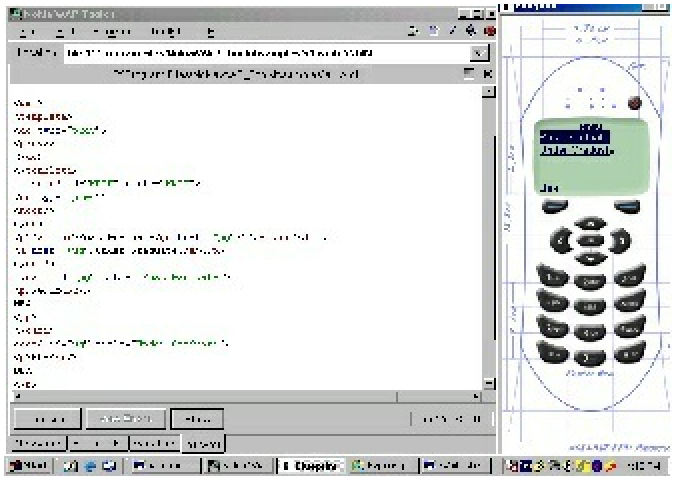
<prev/>

</do>

on each card, instead we can create a <template>



But if you see the first card it also has the back button, which is not required. So, we can use <noop/> task to undo the operation.



Tables

```
<table title=”Title” columns=”3">
<tr>
<td>Line 1 Column 1</td>
<td>Line 1 Column 2</td>
<td>Line 1 Column 3</td>
</tr>
</table>
```

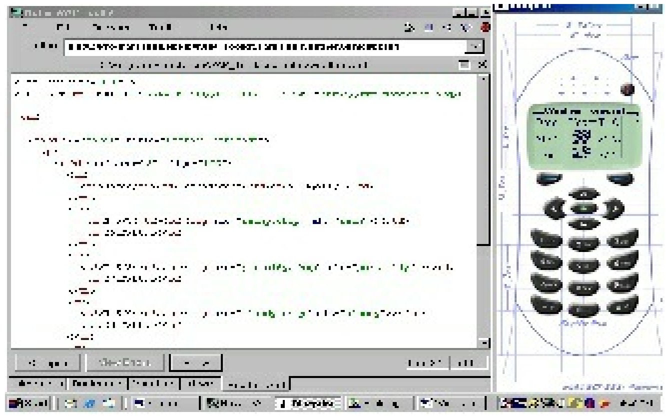
Title	Title of the table
Columns	Number of columns (mandatory)
Tr	Begins a new line (Table Row)
Td	Begins a new column (Table Delimiter)

Images

The WBMP format (Wireless Bitmap) is used to code images under WML. Nokia has a DOS based conversion utility.

```
<img src=”bild.wbmp” alt=”Text”>
```

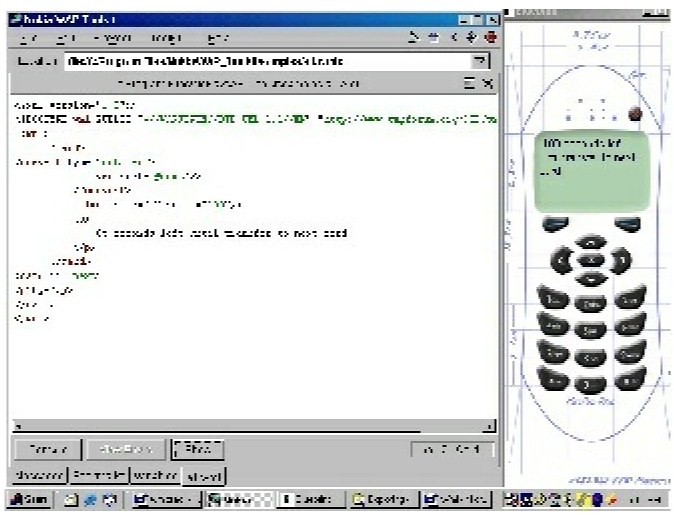
src	URL des Bildes
alt	Alternative text (mandatory)
align	"top", "middle", "bottom" (alignment)



Events

Events have a Card react on certain triggers

Ontimer	The expiration of a timer and the entry into a card by <go> and <prev>.
Onenterforward	When you click Forward
Onenterbackward	When you click Backward

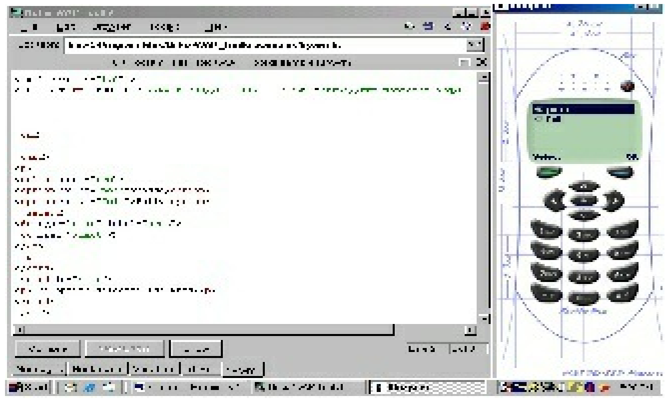


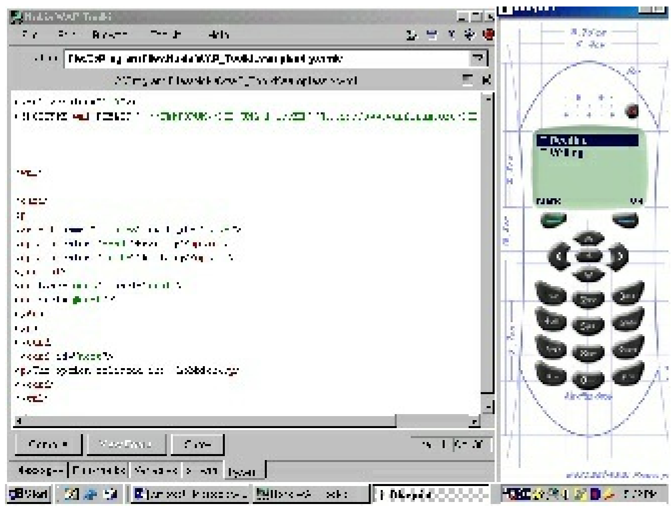
Interaction

Select Boxes

Used for user interaction

<select> <option>Pass</option> <option>Fail</option> </select>	<select multiple="true"> <option>Reading</option> <option>Writing</option> </select>
Will display Radio Buttons Pass Fail	Will be displayed as Check-box Reading Writing





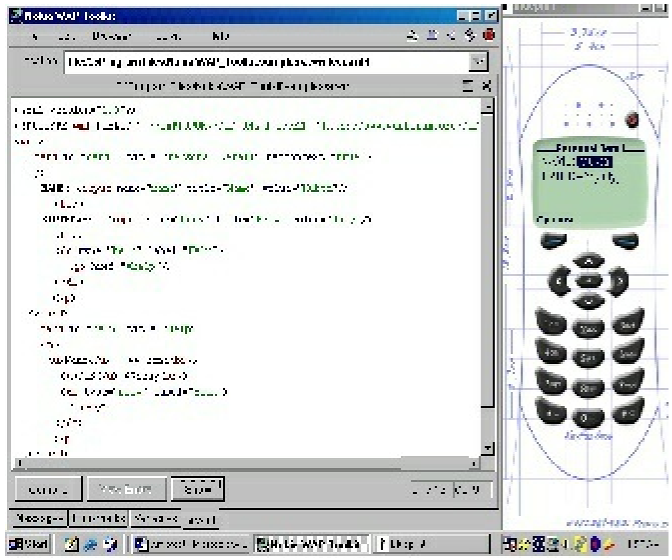
Input

<input> generates a text entry field and validates the entry against a format specification. The value is returned in a Variable.

<input name=”Name” value=”Template”/>

Name	Name of the receiving Variable
Value	Template
Type	"text", "password"
Format	Mask (e.g. A uppercase letters, N numbers)
Maxlength	Maximum length of entry field
Title	Title

A <fieldset> groups input tags logically.



Variables

Variables are a powerful enhancement of HTML functionality. They are used to proliferate status information or user entries from one Card to another or to the server. Variables are prefixed by a dollar sign ($). Therefore if a $ sign should be used, you have to write $$.

<p>Value of T is $T</p>   Displays the text and the value of variable T.

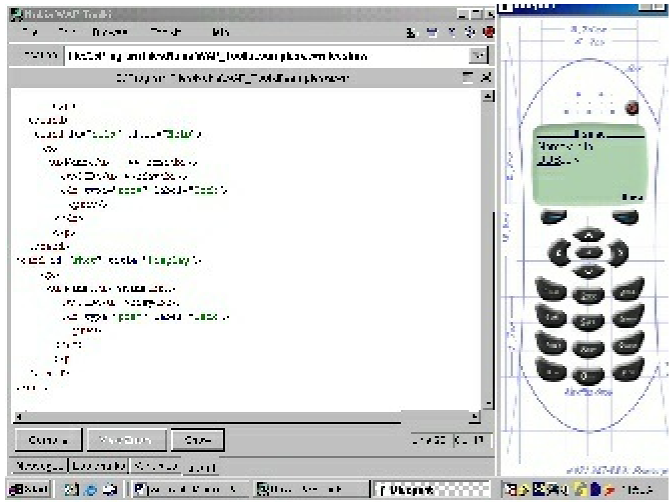
Variables can be set in different ways:

```
<go href=”#card” method=”post”>
   <postfield name=”x” value=”1"/>
   <setvar name=”y” value=”2"/>
</go>
```

Method: “post”/”get” The known HTML mechanisms for data return.

The variable X is set to the value “1” and the URL #card is called with parameter x=1 (as #card?x=1).

The variable y is set to “2”, if this link is selected. <setvar> can be used together with <go>, <prev> and <refresh>.



REVISION EXERCISES

1. Define WAP.
2. Enumerate limitations of Mobile Phones for the internet to move from PC's to mobile.
3. What do you mean by latency in WAP.
4. With the help of a diagram explain the WAP Architecture.
5. Briefly describe the WAP protocol stack.
6. Explain the following terms used in WML:
    a. Elements
    b. Deck
    c. Meta tag
    d. Prolog
    e. Cards
    f. Forward Navigation
    g. Backward Navigation

Chapter 20: MULTIMEDIA

Multimedia is made up of two words multi and media. Multi means many and media means the way by which we communicate. So multimedia can be said as collection of ways by which communication can be done. Hence multimedia can be visualized as a fusion of different modes of media. The personal computer (PC) can now deliver all types of media-text, still images, graphics audio and full-motion video. The personal computer brings to all of this media two other important functions, the ability to present this media in an integrated way and in an interactive way. Multimedia systems combine a variety of information sources into a variety of applications.

The complexity of multimedia applications stresses all the components of a computer system. Multimedia requires great processing power to implement software codes, multimedia file systems and corresponding file formats. The architecture must provide high bus bandwidth and efficient I/O. Multimedia operating system should support new data types, real time scheduling and fast interrupt processing. Storage and memory requirements include very high capacity, fast access times and high transfer rates. We also need new object oriented, user friendly software development tools, as well as tools for retrieval and data management. When multiple sources of media are played back in real time, either locally or in a distributed environment, it can be difficult to maintain the temporal relationships among the media streams, but it is required for coherent playback. These temporal relationships have been defined as inter-media synchronization.

A multiple system consists of three major components; multimedia hardware for video an audio, an operating system for graphical user interface and software development and delivery tools supporting multimedia data. An ideal multimedia system should be capable of handling both motion video and synchronized audio.

Also, a multimedia system should be capable of transmitting real-time video and audio across a LAN or digital telephone network.

COMPRESSION

Multimedia system require data compression for three reasons: large storage requirements of multimedia data, slow storage devices and insufficient network bandwidth for real-time transmission of multimedia data.

For example, a typical multimedia application might store more than 30 minutes of video, 2000 images and 40 minutes of stereo sound. That would require about 50 GB of storage for video, 15 GB for images and 0.4 GB for audio. This means a total of 65.4 GB of storage space is required. You can very well imagine how large this space is ! At the present stage of storage device technology the only solution is to compress the data before storage and decompress it before playback. Compression techniques can be classified into two categories: loss less and lossy approaches. Loss less techniques are capable of perfectly recovering the original representation. Lossy techniques involve algorithms that recover presentation similar to the original one. The lossy techniques provide higher compression ratios, therefore, they are more often applied in image and video compression then loss less techniques. Various groups have established standards for digital multimedia compression based on existing JPEG, MPEG, etc.

For the past few years, a standardization effort known by the acronym JPEG, for Joint Photographic Experts Group, has been working towards establishing the first international digital image compression standard for continuous-tone (multi-level) still images, other grayscale and colour. MPEG (Motion Picture Experts Group) is an international standard for the compression of digital audio and video transmission. MPEG was chartered by the ISO to standardize a coded representation of video and audio suitable for digital storage media, such as compact disk-read only memory (CD-ROM), digital audio tape (DAT) etc. The group's goal, however, has been to develop a generic standard, one that can be used in other digital video applications, such as telecommunication. Digital audio compression allows the efficient storage and transmission of audio data. The various audio compression techniques offer different levels of complexity, compressed audio quality and amount of data compression.

COMPONENTS OF MULTIMEDIA

The main components of multimedia are text, graphics, sound, animation. Text is an integral part of any multimedia production and used to add emphasis to presentations. Graphics can be in the form of illustration, charts, maps, pictures, images, etc. Graphics aids better understanding and makes presentation lively. Sound is in the form of voice, music or special effects. Animation can be used to explain complex subjects that are yet to become reality.

Tools and Accessories

- Sound

  Sound can be added in a multimedia presentation work. MS windows comes with a sound editor called sound recorder. The popular sound editor software products are ware of widows, voyager ware player, etc.

- Drawing Software

  There are many hardware and software accessories to create graphics. To create graphics paint or drawing program is needed. These programs can create the graphics ranging from simple squares and circles to complex images. Software available are Corel draw, Adobe PhotoShop, Paint brush on MS windows, etc.

- Video

  Creating video to use on computer is really just a matter of having right tools and following right steps. The first tool is video camera, second is video capture board. The video capture board goes inside the computer and enables the user to capture the video from the video camera. The final tool for capturing the picture is digital video software packages. With these software packages editing can be done easily.

- Scanning

  Another way to create graphics is by scanner. A scanner scans over an image such as photo, drawing logo etc, converting it into an image and this image can be seen on the screen. Using image editors, we can edit the image i.e. adding , removing colours, filtering etc. can be done.

- Animation Software

  There are many animation software packages available that can be used to create 2d and 3d animations. We can use Animation studio, Animator pro, GIF animator, 3d studio max etc.

- Non-Linear Editing

  Importing of audio and its integration with video is a very simple feature of these software. The audio of two channels and the background and foreground audio can be mixed. The software available is Adobe premiere, Media suite pro, etc.

- Authoring

  Nonlinear editing with the capability of interactivity is called authoring. Authoring is a tool by which we will be able to interactively give any graphics or screens for the user according to his choice. The software available are Macromedia director, Multimedia toolbook from Asymmetries etc.

HYPERTEXT AND HYPERMEDIA

In developing hypertext courseware specialized software commonly referred to as authoring systems are used to manipulate and link text and graphics within the computer environment. Hypertext based authoring systems allow documents to be built by defining and manipulating objects on the screen. The author defines navigation buttons which enable predefined links to be built into the hypertext documents; field buttons which are set up to contain text and graphical buttons which can be created within the document or can be exported from the sources. Typical hypertext documents allow the user to browse materials via a computer’s GUI (graphical user interface). A GUI is a visual metaphor which uses icons to represent actual desktop objects that the user can access with a pointing device. The user navigates through the document by clicking on the buttons or hotspots defined by the author. The hypering text model supports the concept of learn enhancing or deepening their knowledge base by establishing new links and new dimensions to understanding by interacting with the material under consideration. Hypertext documents can also provide users with the tool to alter or add to existing material thus blurring the distinction between the developer, the teacher and the learner.

Latest Technologies

With the arrival of the desktop computers new technologies have been developed. Latest trends are developed in the field of multimedia day-by-day. Some of these are:

- Motion Capturing System

  This is a system by which the motion of various living things are captured and integrated into the computer and assigned to the computer generated models so that they also behave in a similar manner. This is achieved by fixing sensors all over the body and allowing the person and the object to act accordingly whereby different cameras are used to capture the motion from all sides.

- 3d Rapid Digitizer

  These are the laser controlled scanners by which any object can be scanned and the output rather than being a 2d images, is a 3d model. All the effects that are applicable to 3d modeling and animation can be performed to this object.

- Motion Tracking Cameras

  These provide a very flexible way of film making. These cameras record their movement and motions and all parameters of the shoot. Later when a computer generated shot is composited on the real shot the camera values can be clear synchronization between the computer generated shoot and real shoot.

- Voice Recognition Systems

  Multimedia is revolutionizing the way we interact with computers. Voice recognition system enables the computers to recognize commands on voice input using digital format. The first step towards this has already been taken by the development of software like Dragon Naturally Speaking and IBM via voice.

- Virtual Reality

  Virtual reality is a revolutionary facile attribute of the advanced computers of today to envelop a user in a 3d simulated world of sight, sound, touch and movement. There are two classes of virtual reality systems, immersive and desktop.

The most common tool used on the internet in terms of 3d graphics is VRML. It is a language used to create 3d multimedia tools. VRML is an acronym for the Virtual Reality Modeling Language. VRML is 3d analog to HTML. This means that VRML serves as a simple, multiplatform language for publishing 3d web pages. This is motivated by the fact that some information is best experienced three dimensionally, such as games, engineering and scientific visualizations, educational experience and architecture. Typically these types of projects require intensive interaction, animation and user participation and exploration beyond what is capable with a page, text or image based format. VRML provides the technology that integrates three dimensions text and multimedia into a coherent model. When these media types are combined with scripting languages and internet capabilities, an entirely new genre of interactive applications are possible. Many have speculated that the 3d world model will supersede and thus replace the popular 2d desktop model as the primary user interface paradigm in the next decade. Of course, there are a variety of challenges that need to be overcome before this is possible, such as 3d user interface and navigating and 3d graphics performance.

Multimedia Application Areas

Multimedia finds application in various fields as:

- Entertainment
- Broadcasting
- Advertising
- Marketing
- World wide web
- Publishing etc.

Multimedia is being used in the supervision of highly automated industrial plants, power stations, manufacturing units etc by way of integrating online electronic documentation facility with the process control system and other video controlled operations.

High speed networking has introduced opportunities for new multimedia applications such as :

- Video conferencing
- Medical imaging
- Scientific visualization

REVISION EXERCISES

1. Multimedia system requires data compression. Why compression forms a very important part of the multimedia application?
2. Illustrate the different components of multimedia.
3. What are the tools and accessories which forms the part of different multimedia components, discussed above ?
4. Explain in brief
   (a) Motion Capturing System
   (b) 3d Rapid Digitizer
   (c) Motion Tracking Cameras
   (d) Virtual Reality
5. How can you effectively make use of different multimedia tools for making a Educational web site?

Chapter 21: DATA WAREHOUSING

Heralded as the solution to the management information dilemma, the term 'data warehouse' has become one of the most used terms in the IT vocabulary.

INTRODUCTION TO DATA WAREHOUSING

The concept of 'data warehousing' dates back at least to the mid-1980s and possibly even earlier. In essence, it intended to provide an architectural model for the flow of data from operational systems to decision support environments. It attempted to address the various problems associated with this flow and the high costs associated with it. In the absence of such architecture, there usually existed an enormous amount of redundancy in the delivery of management information. In larger corporations it was typical for multiple decision support projects to operate independently, each serving different users but often requiring much of the same data. Legacy systems were frequently being revisited as new requirements emerged, each requiring a subtly different view of the legacy data.

Based on analogies with real life warehouses, data warehouses were intended as large scale collection/storage/staging areas for legacy data, from where data could be distributed to retail stores or data marts which were tailored for access by decision support users. While the data warehouse was designed to manage the bulk supply of data from its suppliers and to handle the organizations and storage of this data, the retail stores or data marts could be focussed on packaging and presenting selections of the data to end-users, often to meet specialized needs.

Somewhere along the way this analogies and architectural vision was lost, often manipulated by suppliers of decision support software tools. Data warehousing 'gurus' began to emerge at the end of the 80s, often themselves associated with such companies. The architectural vision was frequently replaced by studies of how to design decision support databases. Suddenly the data warehouse had become the miracle cure for the decision support headache and supplies jostled for position in the burgeoning data warehousing marketplace. Despite the recent association of the terms 'data warehousing' with OLAP and multidimensional database technology and the instance of some people that data warehouses must be based on a 'star scheme' database structure, it is wise to restrict the use of designs to data marts. The use of a star scheme or multidimensional/OLAP (Online analytical processing) design for a data warehouse can actually seriously compromise its value for a number of reasons:

- Such designs assume that all queries on the warehouse will be of a quantitative nature- i.e. on aggregated numeric data. This overlooks the fact that data warehouses can also offer enormous benefit as repositories of text-based or qualitative data.

- Such designs require the pre-aggregation of data in the data warehouse. In doing so and eliminating much of the original transactional data, much information can be lost. If information requirements change, a star or multidimensional design will quickly become obsolete. A normalized design which accommodates transactional level data would be able to support any number of alternative aggregations. While capacity and / or performance constraints may preclude this as an option for some data, the storage of low level transactional data in a data warehouse should not be ruled out.
- Optimized models such as star schemes are less flexible than normalized designs. Changes to business rules or requirements are generally more easily accommodated by normalized models.

DATA WAREHOUSING: AN EXPENSIVE CONCEPT

While the data warehousing concept in its various forms continues to attract interest, many data warehousing projects are failing to deliver the benefits expected of them and are excessively expensive to develop and maintain. The cost of data warehousing projects are usually high. This is explained primarily by the requirement to locate, clean and integrate data from different sources-often legacy systems. Such exercise is inevitably labor-intensive and time-consuming, but is essential to the success of the project. The cost of extracting cleaning and integrating data represents 60-80 percent of total cost of a data-warehousing project.

Given the high costs, it is difficult to justify a data-warehousing project in terms of short-term benefit. If a point solution to a specific management information need, a data warehouse will often struggle to justify the associated investment. It is as a long-tern delivery mechanism for ongoing management information need that data warehousing reaps significant benefits. The focus must be on the reduction of the ongoing cost of data extraction, cleaning and integration. Reasons for previous data warehousing projects being very costly are:

- 80 percent of the data used by the various data warehouses access the corporation from the same 20 percent of source systems.
- Each new data warehousing project usually carried out its own process to extract, clean and integrate data from the various sources, despite the fact that much of the same data had been the subject of previous exercises of a similar nature.
- The choice of data to be populated in the data warehouse was usually based on needs of a specific group, with a particular set of information requirements. The needs of other groups for the same data were rarely considered.

From these findings it is clear that there is a scope for economics of scale when planning data warehousing projects. If focus were to be placed initially on the 20 per cent of source systems which supplied 80 per cent of the data to decision support systems, then an initial project which simply warehouses 'useful' data from these systems would clearly yield cost benefit to future MIS projects requiring that data. Benefits should be aimed at the wider audience for decision support. This would form an invaluable foundation for an evolving data warehouse environment.

When building a data warehouse the use of multidimensional, star-scheme or other optimized designs should be strongly discouraged, in view of the inherent inflexibility in these approaches. The use of a relational, normalized model as the backbone of the warehouse will ensure maximum flexibility to support future growth. If user query access is then strictly limited to data marts, the data warehouse needs only to support periodic extracts to data marts, rather than ad-hoc query access. Performance associated with these extracts can be addressed in a number of ways, e.g., through the use of staging areas (either temporary or permanent) where relational table structures are pre-joined or 'flattered' to support specific extract process.

Emphasis can be placed on the growth of the warehouse as a global resource for unspecified future decision support needs, rather than as a solution to specific requirements at a particular time. In subsequent phases of development, new data, which is likely to play a major role in future decision support needs, should be carefully selected, extracted and cleaned. It can then be stored alongside the existing data in the warehouse, hence maximizing its information potential. As new information need energy, the cost of meeting them will be diminished due to elimination of much of the costly functions usually associated with such systems.

Over a period of time, this environment will grow to offer a permanent and invaluable repository of integrated and enterprise wide data for management information and decision support systems. This will lead to massively reduced time and cost to deliver new decision support offerings and to true cost justification.

Once in the warehouse, data can be distributed to any number of data marts for user query access. These data marts can take any number of forms, from client-server database to desktop databases, OLAP cubes or even spreadsheets. The choice of user query tools can be wide and can reflect the preferences and experience of the users concerned. If the warehouse data is well structured and quality is assured, then exporting it to new data marts should be a routine and low-cost operation.

THE FIVE DATA WAREHOUSING MISTAKES

Whenever you may be in your data warehousing journey and what ever challenges you may be facing, rest assured that scores of others have gone before you. And like true pioneers in most endeavors, the data warehouse trailblazers made some egregious mistakes. But, you can learn from their errors. According to data warehousing disciple, Alan Paller (Co-founder and Director of Training, Data Warehousing Institute) the five mistakes to avoid are:

Different Access Tools for Different Users

Remember the golden olden days, when IT would buy separate graphics packages for each different word processing package? Many misguided IT professionals purchase (and support) one kind of data access package for the 'push-button' or very novice user, another package for the simple query user, another for the smart query user and still another for the hard-core OLAP users and financial analysts. Apart from the expense of the software and steady stream of upgrades, training users on multiple packages carries its own financial penance. The vast majority of users need all four of these features at different times. So it makes the most sense to shop for access and analysis tools that are flexible and which span the spectrum of access features that users need.

Underestimation of User Demand

From studies of its user members, the Data Warehousing Institute (DWI) has formed that the member of users double after three months, after six months and yet again a year after that. Ironically, it is the very success of the warehouse that continually begets more users-who is turn beget more users.

Is it any wonder that the cozy warehouse project for 200 that you budgeted for last January has ballooned to 1,600 users in a mere 18 months? And at every step of this torturous road to mass warehouse use, that IT has chronically misforecast hardware needs?

Exacerbating the situation is a tendency on the part of hardware vendors to low-ball initial hardware requirements, perhaps knowing fully well that IT will be moving for more hardware in no time, presumably from the same vendor. And as warehouse data is increasingly made available on corporate Intranets, network capacity planning comes to the fore. Fortunately, the payback and return on investment of data warehousing is prodigious. Justifying the cost of a warehouse is not the problem-unless you err by miscaliberating from the outset and find yourself knocking on executive doors every few months, begging for more hardware.

Confusing and Inconsistent Data Definitions

By doing so, your warehouse will more closely resemble a chaotic, confused tower of Babel rather than a denormalized database easy for non-programmers to pursue. The data warehousing Institute reported that one company's database contained 27 different definitions of sales. Historically, department managers command IT to build data definitions in ways that reflect positively on their discrete departments. So for example, 'sales' to the shipping department is what needs to be delivered to customers. To the financial department 'sales' is the difference between total revenues and returns. And to the sales/marketing department, 'sales' is what clients have committed to buy. These are all different definitions that are bound to create confusion over the time and will lead to a data warehouse built on top of a foundation of inconsistent data definitions. Sales are sales, right? When the warehouse architects fail to fight the battle for definition reconciliation, the users can lose faith in the quality of data they're analyzing.

Most Effort Spent in Cleaning the Data

THE DWL estimates that 70 percent or more of the work involved in a warehouse is in the data transformation stage, or in prepping operational and third party data for shipment to the warehouse. Much of that time is spent by IT programmers on niggling issues, such as figuring out the best way to put monthly data into daily data files. "Problems associated with cleaning up bits and pieces of data hare an uncanny way of showing up at 4 PM on Friday afternoon, " says Paller. The penance, in this case, is a long weekend in the office resulting from incorrect estimates of programming intensity.

Another aspect is the basic failure to acknowledge that warehousing and OLTP are fundamentally very different approaches by IT to database technology. As warehouse users (non-IT people) gain experience, they expect the data they access to be in aggregate form, such as sums and trends. Eventually they'll want that data is precalculated for them, ready to pop up on their screens with the click of a mouse. OLTP data it isn't.

Build an Underachieving Data Warehouse

Design, implement and manage a data warehouse that help your company know its customers better than the competition does. Then give analysts dazzling new insights into costs. You will gain unparalleled respect from upper management and users. Fail to build such a value-added warehouse and you could end up on a different path altogether.

If you want to start small with your mistakes, oversee the construction of data marts that lack a central architecture.

STRATEGIC VALUE OF DATA WAREHOUSES

Speed, flexibility and foresight are the primary characteristics that distinguish successful organizations in this information age. Businesses of the 90's must have management processes in place to monitor and control the organizations while at the same time decentralizing decision-making in order to react to competitive changes and take advantage of unexpected opportunities. One central element that supports this balance between control and flexibility is shared knowledge. Such knowledge, derived from both internal and external data sources, is converted to information, which can be readily interpreted. If knowledge and intellectual capital are becoming the key drivers of competitive advantage, then the intelligent organization is the one that can modularise, standardize and broadly share its knowledge both internally and in many cases externally. These are the companies that continually transform their knowledge bases in the context of a changing business strategy. Information systems play a role in creating and distributing that knowledge. Specifically, the data warehouse, a central repository of subject oriented data originating from the companies transactions systems and external data sources, become a critical information system. The successful implementation of a data warehouse can have a significant effect in fostering a culture of knowledge sharing.

While business quest for knowledge has never been greater, slightly less than half of data warehousing efforts have failed to deliver. On average, companies spend 5 million dollars implementing data warehouses. Of these, approximately 60% will say the effort did not successfully provide the return on investment. When on utilized correctly it can provide insights performance, profitability, cost structures etc. but, like any well - grounded research effort, the data that is collected and organized must relate specifically to the areas of study or interest must be pursued later and in stages. Many organizations have missed the mark by not setting specific objectives for the data warehouse efforts that relate to the overall business strategy.

MANAGING INFORMATION AS AN ASSET

Intellectual Capital: The New Wealth of Organizations', Thomas A. Stewart captures the essence of one of the biggest problems with data warehouses today. He writes " knowledge assets, like money or equipment exist and are worth activating only in the context of strategy. You cannot define and manage intellectual assets unless you know what you are trying to do with them. It's important to separate trivial and transitory information from important intellectual assets, especially in an era of numbingly rapid change." Three key reasons for failure of enterprise data warehouses include:

- Their purpose is not defined and prioritized in the context of the overall strategy;
- They attempt to collect all information including that which may be "trivial or transitory", or peripheral to the real need; and
- They take too long to deliver so that the business has changed out from under them.

In other words, they collect first and understand needs later. Ideally, the data warehouse should be managed as a company asset. It should be continually reviewed in the context of the investment objective and it should have high level resources dedicated to managing it.

The Typical Data Warehouse Failure

The following is typical of a data warehouse effort gone away. A high growth company adding three tele-sales service centers a month wishes to measure productivity of the centers and evaluate the quality of those service centres. Nine months and eight hundred thousand dollars later, nothing of tangible benefit has been delivered to the executive and the project is halted. On inspection of what happened, it is uncovered that the information systems organization has been frantically trying to deliver a 500 GB data warehouse. The problems found are numerous and nearly ubiquitous in data warehousing projects today.

They Include:

- Data that is required is not collected or not accessible.
- Initial database scope was too broad trying to contain too much information too soon.
- Not enough time was spent prototyping or understanding the real business needs in depth.
- Besides the initial project approval, senior management did not provide much direction on terms of priorities, resulting in a disconnection between the data needed and the data gathered.

Given the high rate of failure of data warehousing efforts, an alternative methodology is required. By revisiting the data warehouse in the context of specific business agendas, many organizations can reorient the data warehouse, establish targeted applications via the use of data marts and add value to the business.

AN APPROACH TO DATA WAREHOUSING

Successful organizations will adopt a manufacturing paradigm to manage their information assets. The need for just in time information will drive decisions regarding the 'how comprehensive the data warehouse will be'. Data alone is like inventory, which is expensive to maintain, carrying excess inventory is inefficient and costly. Likewise, data alone is useless and costly to maintain until it is turned into a finished product in the form of delivered knowledge to the business users. As in manufacturing, design begins with the end product in mind. Research is performed to determine which of a variety of raw materials results in the best final product. Then, these raw materials result in the best final product. Similarly in designing data warehouse there are materials (data transactions) which are used to generate components (subject oriented data warehouses). The components are assembled into products (data marts), which are distributed via various means (Internet, Intranet, reports PC applications). The products are then continually reviewed, enhanced, upgraded or discontinued. With this in mind five important steps in approaching data warehousing are outlined below:

- Align the data warehouse with the business objectives. A data warehouse must be driven by a specific need. The most successful data warehouse are often developed in industries undergoing significant change. Some examples are, in health care as managed care increases, utilities as deregulation is pending, or telecommunications as long distance, local, cellular and cable services are merging.

- Create a business driven information architecture. An important step in developing a data warehouse is the development of an information architecture plan that aligns the business objectives of the users with the data that is required. Three essential deliverables from the architecture plan should emerge.

    - What data to include in the warehouse based on specific business relevance,
    - What infrastructure changes must be made to support the data warehouse and,
    - What the delivery mechanisms will be.

  Organizations often rush to include all possible detail in the initial data warehouse implementation when perhaps it is unnecessary. Often historical data can be kept at a greater level of summarization than more current data and specific detail transactions may not be required for the high priority needs. By creating an information architecture plan, the trade off including certain pieces of data can be assessed.

- Be focused-build the foundation in a modular fashion. Homebuilders do not lay down 20,000 square foot foundations to support 3,000 square foot houses. They also do not build all the foundations in a new development and then complete the houses. They establish a plan that lay out the lots and placement of homes, determine the infrastructure requirements and build the housing development incrementally. This is the approach that should be adopted in building data warehouses. Organizations that try to build the enterprise data warehouse to meet all users' needs at once inevitable fail. The building and maintaining of an enterprise data warehouse is a time consuming, difficult and never ending task. By first planning information architecture an overall design for the enterprise data warehouse, but actually building it in increments, more focus can be put on the data mart or delivery mechanisms for high priority business issues. Users desire business value quickly which will fuel momentum for expanding the warehouse.

- Create dynamic data marts. Data marts are focussed applications utilizing a subset of the information from data warehouse and embellishing that data by applying a rich set of business rules and logic to generate a targeted analysis. A data mart is not necessarily a "departmental" application. Churn analysis, a common application in telecommunications among other industries is utilized not just by marketing, but by customer service, sales and finance. These organizations need to determine what causes churn, how much financial impact it has on the company and how the sales and customer service areas may be able to prevent churn.

- Manage expectations about data quality and compromise.

IS YOUR DATA WAREHOUSE IN NEED OF REJUVENATION?

If your data warehouse has been subjected to scope creep, changing usage patterns or inappropriate design, it may be suffering from suboptimal performance. Use the stepwise approach to find out just how badly it is suffering.

Pick a Subject: Choose a subject area of your warehouse that satisfies a diverse range of queries and that has been in use for at least six months.

Collect Sample Queries: Collect 10 queries that describe your chosen subject. The queries collected must satisfy the following criteria:

- Actual "select" statements submitted by users – If you do not have a log of the SQL submitted by users, find saved versions of queries on the users 'PCs'.
- Machine written queries – Choose queries that have been generated by a business intelligence tool, not ones that have been optimized by hand.
- Random sample – If you hand pick the queries, you will introduce a bias.
- Multiple sessions – choose queries from different users in order to avoid collecting 10 queries from a single analysis.

Design for the Sample: Design a "10 query scheme". This is a theoretical database scheme. It includes only the data items that are required for your 10 sample queries. The "10 query scheme" is not purely a reduced column version of the existing scheme. Reconsider the degree of de-normalization and the granularity of the data in order to come up with a design that will yield the least total I/Os for the 10 queries in your sample.

Compare I/O: For each query, estimate the total I/O (in bytes) under the existing warehouse design and under the "10 query scheme". Add the I/O counts for the 10 queries to arrive at a grand total for each design.

If you already have your own reliable means of I/O country, use it. If not, use the simplified method of I/O counting outlined as below:

Generic method for I/O counting:

- Work out the order in which the tables will be accessed by examining search arguments, joins and indexes.

- Work out which index will be used for each table.
- Start with the first table and count the number of I/Os in bytes. Add the number of I/Os for subsequent tables. Assume that the joins are accomplished by means of nested iteration. If you know that your database engine uses a move optimal join strategy, reduce the I/O count.
- Treat all I/O as "logical". For this exercise, it is not necessary to make a distinction between physical and logical I/Os.

The following formula will be useful:

I/Os for Table Scan – Table width (Bytes)* Total Row Count for Table.

I/Os for read using non-clustered index =(Index Width (Bytes)+Table Width [Bytes]) * Number of rows read.

I/Os for read using clustered index = (Table width [Bytes])* Number of rows read.

I/Os for nested iteration = Number of I/Os per iteration * No. Of Iterations

At the end of stop 4 you will have two figures – I/O count for existing design and I/O count for sample design.

Draw Inference: Calculate the opportunity for rejuvenation by using the formula below:

Opportunity for rejuvenation = log [(I/O count for existing design)/ (I/O count for sample design)]

Your warehouse design can be improved, but if improvements are made at the expense of additional complexity, expert the benefit to be marginal. Look to make simple improvements. E.g. try and find and remove any excess baggage from your warehouse.

There are definite opportunities to benefit from design changes to your warehouse. Consider narrowing the scope of the subject, introducing more levels of granularity, redesigning your diversion tables, or adopting a decision support architecture that is less performance hungry.

DATA WAREHOUSING: POSSIBLE PROBLEMS AND COMPLEXITIES

You are going to spend much time extracting, cleaning and loading data. The data warehousing books, estimates that, in average, 80 percent of the time building a data warehouse will be spent on this type of work.

Despite best efforts at project management, data warehousing project scope will increase. To paraphrase, traditional projects start with requirements and end with data. Data warehousing projects start with data and end with requirements. Once warehouse users see what they can do with 1990's technology, they will want much more. Which is fine! One piece of advice for the warehouse builder is never to ask the warehouse user what information he wants. Rather, ask what information he wants next.

You are going to find problems with systems feeding the data warehouse, problems that have gone undetected for years will pop up. You are going to have to make a decision on whether to fix the problem in what you thought was the 'reading-only' data warehouse or fix the transaction processing system. In this case the data warehouse developer faces the processing system or building a system dedicated to capturing the missing information.

Need for Validation

You will need to validate data not being validated by transaction processing systems. Typically once data are in warehouse many inconsistencies are found containing 'descriptive' information. For example, many times no controls are put on customer names. Therefore, you could have 'DEC', 'Digital' and 'Digital Equipment' in your database. This is going to cause problems for a warehouse user who expects to perform an ad hoc query selecting on customer name. The warehouse developer, again, may have to modify the transaction processing systems or develop (or buy) some data scrubbing technology.

Some transaction processing systems feeding the warehousing system will not contain detail. This problem is often encountered in customer or product oriented warehousing systems. Often it is found that a system which is feeding information to the warehousing systems does not contain information down to the product or customer level. By the way, this is what some people label as a granularity problem.

You will under budget for the resources skilled in the feeder system platforms. In addition to understanding the feeder systems data, you may find it advantageous to build some of the "cleaning" logic on the feeder system platform if that platform is a mainframe. Often cleaning involves a great deal of sort/merging tasks at which mainframe utilities often excel. Also, you may find that you want to build aggregates on the mainframe because aggregation also involves substantial sorting.

Training for What?

Many warehouse end users will be trained and never or seldom apply their training. A study claimed that only one quarter of the people who get training in a query tool actually become heavy users of the tool.

After end users receive query and report tools, requests for IS written reports may increase. This phenomenon was seen with many of the information centers of the 1980's. it comes about because the query and report tools allow users to gain a much better appreciation of what technology could do. However, for many reasons the users are unable to use the new tools and to realize the potential. By the way, if this happens do some honest research on why. Granted these are many reports that are so complex that IS expertise is going to be required no matter what tool the end user has. However, many times this phenomenon points to training needs.

The Right Business Rule

Your warehouse users will develop conflicting business rules. Many warehouse tools allow users to perform calculations. The tools will allow users to perform the same calculation differently. For instance, suppose you are summarizing beverage sales by flavor category. Also suppose that the flavor category includes cherry and cola. If you have a cherry cola brand there is a chance that two users will classify the brand in different categories. You will find that there are means to incorporate some of the business rules in your warehouse. However, the number of possible business rules is so large that you will not be able to incorporate all rules.

Large scale data warehousing can become an exercise in data homogenizing. Data have quirks! Sometimes when developers combine detailed data for different subjects, in their efforts to make everything 'fit' they can take the life out of the data. For instance, if your company sells dog food and auto tires, you want to be careful if you are building a sales data warehouse for both lines of business. You have to make a judgement call as to whether these businesses fit the same logical and/or physical model.

Space War

'Overhead' can eat up great amounts of disk space. A popular way to design a decision support relational database is with star or snowflake schemes. Personnel taking this approach usually also build aggregate fact tables. If there are many dimensions to the data, be aware that and indexes to the fact tables and aggregate fact tables can eat up many times more space than the raw data. If you are using multidimensional databases, be ware that certain products pre-calculate and store summarized data. As with star/snowflake schemes, storage of this calculated data can eat up for move storage thin the raw data.

The time it takes to load the warehouse will expand to the amount of the time in the available window. You'll do yourself well by understanding the different ways to approach updating the warehouse. Before you decide that you can do complete refreshes, be aware that "There's all day Sunday to load the database!" have been famous last words of more than a handful of warehouse developers.

Right to Access

Assigning security cannot be done with a transaction processing system mindset. At a conference a speaker discussed how data ware housing requires a philosophical shift from the “need to know” to the “right to know”. So, if you are building a sales information system, if you are letting the Midwest manager for bon-bons see only his sales and are excluding him from seeing the western region sales for crusty rolls, think twice! There may be some information useful for bon-bon sales in that crusty roll information. By the way, this is not necessarily advocating wide open access. It is just a warning for you that if you deal with security (and many organizations are, to great danger, avoiding it), you will have both a technical and philosophical challenge.

You are building a high maintenance system. Reorganizations, product introductions, new pricing schemes, new customers and changes in production systems etc., are going to affect the warehouse. If the warehouse is going to stay ‘current’ (and being current will be a big selling point of the warehouse), changes to the warehouse have to be made fast.

You will fail if you concentrate on resource optimization to the neglect of project, data and customer management issues and an understanding of what adds value to the customer. If you provide a system that is fast and technically elegant but adds little value or has suspect data, you will probably loose your customer from day one and will have a tough time getting him back. For the most part, use of data warehousing systems is optional. The customer has to want to use the system.

INTELLIGENT WAREHOUSING FOR ERP SYSTEMS

Thousands of companies around the world have made substantial investments in Enterprise Resource Planning (ERP) systems and they now expect (not unreasonably) to earn returns on those investments. However, while ERP systems have straitened day-to-day processes and satisfied a variety of operational concerns, they have not and they themselves cannot deliver substantial and lasting competitive advantages. Achieving such advantages requires a different category of software – information delivery/decision support software – which can access ERP data and organize it for business – intelligence purposes.

The ERP Rush

In many respects, ERP is clearly a major advance. Organizations are no longer committed to writing hundreds of thousands of lines of Cobol or other third – generation software languages to perform standard tasks such as order fulfillment and logistics. ERP vendors such as SAP, People Soft, Baan and JD Edwards have developed predefined solutions, so organizations can invest in ready-made standard business applications.

And once it has been adopted as "the corporate standard", the whole company can adapt to it. Everything is linked together, so that when the company issues on invoice, it does not just register in the financial module, but also anywhere else that is relevant; materials management, logistics and so on. Compared with the traditional way of running things, with high maintenance costs, application backlogs and poor system documentation and integration, ERP had to be a better way of doing things. For many, ERP holds the promise of an integrated enterprise, bringing improved operational efficiency, better productivity and increased profitability.

Consequently organizations are prepared to invest significant amounts of resources into ERP systems. Ironically though, it seems that the bulk of the expenditure goes into the constancy and systems integration fees that must be thrown at ERP systems to make them work. IDC estimates that revenue generated from consulting and integration services for enterprise resource planning (ERP) systems will exceed $34 billion by 2002. Interestingly, IDC found that organizations are spending nearly three times as much on ERP related consultancy and integration services as they are on ERP software itself.

Nevertheless, most large organizations have been smitten by ERP. At least 70 per cent of fortune 1000 firms have, or soon will have, ERP systems in place. What is less clear is whether organizations are truly convinced of the benefits of ERP or simply fearful of the consequences if they do not follow their competitors. ERP is seen as very good for process-management purposes, so it is highly regarded by the middle managers responsible for operations. But questions and doubts are beginning to surface at the more senior levels of management, where the costs are immediately apparent, but less so the benefits.

Competitive Parity or Advantage

Thomas H. Davenport has very eloquently articulated a new concern in his 1998 Harvard Business Review paper, putting the Enterprise into the Enterprise System. According to Davenport, "when developing information systems in the past, companies would first decide how they wanted to do business and then choose a software package that would support their proprietary processes. They often remote large portions of the software code to ensure a tight fit. With enterprise systems, however, the sequence is reversed. The business often must be modified to fit the system. An enterprise system is, after all, a generic solution. Its design reflects a series of assumptions about the way companies operate in general. Venders try to structure the systems to reflect best practices, but it is the vendor, not the customer, that is defining what 'best' means …. "An enterprise system, by its very nature, imposes its own logic on a company's strategy, organization and culture". Devenport asks chief executives to ask themselves the following question: "How similar can our information flows and our processes to be those of our competitors before we begin to undermine our own sources of differentiation in the market?".

Commentators like Devensport acknowledge the tremendous advantage that ERP systems bring to organizations. But ultimately, the standardization of business processes can only lead to one conclusion Competitive Parity. The returns on efficiencies achieved through standardization of business processes will diminish, because competition will drive all organizations to the same standard levels of efficiency. As everybody's business processes become the same, business costs are drives down to a common base level.

So how will businesses compete in the future? Davensport quotes an ironic remark from the CEO of a large chemical firm: "Competitive advantage in this industry might just come from doing the best and cheapest job at implementing SAP".

Liberating ERP Data

In reality, the outlook is not so bleak.

With the ERP systems, the focus has been essentially on the capture of data and using that data to fuel the organizations business processes as efficiently as possible. The problem is that the data has stayed locked into the ERP system and the challenge is to liberate it for other, more creative purposes. ERP data has the potential to tell an organization a great deal about its business processes, the organizations customers, its suppliers, the competitive environment, core competencies and how best to deploy the organizations resources. If the organization can succeed in getting at this data and converting it into useful information, it has the opportunity to discover unique advantages that will take it beyond competitive parity. But, as long as the data in locked into the ERP system, it is useless for these purposes.

ERP software permits organizations to manage resources across the enterprise and enables the integration of various standard operational functions. The key word here is operational. ERP is concerned with the day-to-day processes that are similar in all businesses. Indeed, as we have seen, ERP software has a tendency to eliminate all differences in business processes between one organization and the next, a tendency to make these processes identical, this is not to downplay the importance of achieving efficiencies in day-to-day processes -in today's business environment, any organization that fails to do so will not survive. Operational systems create sizable amounts of raw data, which has the potential to provide the organization with tremendous amounts of information about its business performance, customers, competitive environment, sales channels and so on.

So why do ERP systems fail to deliver this information?

Some key strengths of SAP R/3 and other ERP systems are precisely the barriers preventing them from becoming effective for information delivery, which SAS Institute defines as "the process of turning raw data into meaningful information to support successful decision making". For example, the business rules-based structure that is central to process efficiencies makes ERP very ineffective for providing high-level overviews of the organization.

Information delivery requires maximum flexibility in the data structure. If you need to restructure data every time you query an operational system, the wait times for a report become intolerable – assuming it is possible to get the information you want at all. ERP systems are sufficient if you want to find out the latest status of, say, a sales order. But to see and predict trends, companies need consolidated historical information, which ERP systems are not designed to provide. Information delivery solutions gather information at regular intervals, "time stamp" it and can combine it with external data sources. This creates the basis for comparisons and thus leads to better decision making.

The technology at the heart of information delivery is data warehousing. The fundamental distinguishing characteristics of a data warehouse, as compared with data systems in the operational environment, are as follows:

- Subject-orientation

- Time-variance
- Non-volatility
- Integration of heterogeneous data sources.

Data is organized by subject to ensure easier and faster reporting. For example information about customers from several sources can be summarized and consulted. Additionally, time is an implicit part of the information held in a data warehouse. In an operational system, the data always reflects the state of business activity as of now. By contrast, the information in a data warehouse supports, among other things, trend analysis. Therefore the data is loaded with a “snapshot” of the same information at different times, to allow trend analysis. Information available in data warehouse is there to be read, not modified. The information is therefore nonvolatile. Updating or refreshing the data warehouse means loading a new snapshot of data to the existing data. As data is loaded into the warehouse, it must be integrated into a consistent structure that meets business intelligence needs. Moreover, data organizing is for business intelligence purposes and we exploit it by using business intelligence tools such as OLAP and data mining. Any solution must be flexible, allowing it to easily meet new and changing business needs. It is not simplify a once-and-for-all data storage mechanism.

DATA WAREHOUSING FROM ERP VENDORS

The promise of client/server computing was more than just putting data on desktops. It was to enable managers at all levels to understand and manage their business from their desktops. ERP has failed to deliver on this promise; that is to say, while it has increased the level of process automation it has not significantly improved management’s ability to exploit information. ERP-centric data warehouse solutions have done little to reverse this situation. Although third-party tools are required to access non-ERP data, there are ERP-specific data warehousing solutions in the market that do not address the central requirement of an enterprise data warehousing strategy, to be able to access and integrate heterogeneous data sources. These heterogeneous data sources could be internal (legacy systems), external data sources and multiple instances of an ERP system(s) such as R/3. If there is a divergence between the business rules governing these disparate data sources, this inevitable adds to the complexities involved in extracting and combining R/3 data and non-R/3 data for reports. Alternatively, the data sources could be external (from suppliers and partners, or from information suppliers such as credit ratings, demographic and market research data and market feeds). For this reason many analysts insist that the optimum strategy is to buy on the basis of core competence. Invest in ERP from an ERP vendor and data warehousing from a date warehousing vendor. This is particularly important if any of the following conditions apply:

- Legacy data has to be combined with ERP data.
- There is more than one instance of the ERP system.
- There is more than one data source.

When selecting a data warehousing solution, the future as well as current requirements should be considered. Data is only likely to remain homogenous up until the next merger or the next reorganization. A major advantage of a truely intelligent data warehousing solution is that it is robust, flexible, open and scalable enough to allow the rapid integration of virtually and new data source.

Since speed of response is key to operational systems, it makes sense from the ERP perspective to separate ERP from data warehousing. The increased level of process automation with ERP brings faster response times, however, when combined with decision support requests, their response times may decline significantly each time the data is exploited. For example, if a bank's customers are forced to wait for service at a teller machine every time management query is being executed, they are likely to take their business elsewhere! However, there is an important organizational dimension to this: separation of the technology does not imply separation in management.

DATA MINING: THE NEW PARADIGM

Over the past three decades, computers have been used to capture details of business transactions such as banking and credit card records, retail sales, manufacturing warranty and telecommunications etc. The data from these transactional system have thumb prints of the key trends that impact various aspects of each business – products that sell together, sources of profits, factors that affect manufacturing quality etc. This data is gathered over time and stored in a separate database called a data warehouse.

While operational data deals with daily activities, the warehouse data is historical in nature and is used to obtain perspective on the business trends. In time the insights gathered from the analysis of historical data are used to improve business decisions.

Data mining is the automatic extraction of patterns of information from historical data, enabling companies to focus on the next important aspects of their business – telling them what they did not know and had not even thought of asking.

Industry surveys clearly indicate that over 80 per cent of Fortune 500 companies view data mining as a critical factor for business success by the year 2000. Many such companies now collect and refine massive quantities of data in data warehouses.

These companies realize that to succeed in a fast-paced world, business users need to be able to get information on demand. And they need to be pleasantly surprised by unexpected, but useful, information. There is never enough time to think of all the important questions – the computer should do this itself. It can provide the winning edge in business by exploring the database itself and brings back in valuable nuggets of information. Many organizations now view information as one of their most valuable assets and data mining allows a company to make full use of these information assets.

Decision Support

Decision support is a broad term referring to the use of information as a strategic corporate asset, enabling companies to utilize their databases to make better decisions. Decision support systems have traditionally realized on three types of analysis.

- Query and Reporting

  Where a user asks a question like “what were the sales for a specific product”.

- OLAP

  This arguments to the processing of queries along multiple dimensions such as state, month, etc.,

- Data Mining

This provides influence factors and relationships in data like, "What impacts sales in New York for a given product".

We can view the progress of the field over the last 30 years in terms of a series of steps each providing better and more refined information.

With statistics and reports, just summaries of data were available to business users. And, the data could only be obtained by request from an analyst. With data warehousing, some query and reporting could be performed by business users on their own.

With OLAP, multidimensional summery questions could be addressed by business users, like finding out the total of sales by product, by channel, by month. With data mining, analysts and a sophisticated subset of business users could gain insight into the influence factors and trends in data. But often significant analysis was needed before key questions could be answered.

With knowledge access, almost all the relevant patterns in the data are found beforehand and stored for use by business users. Business users get the interesting patterns of change every week or month or can query the pattern – base at will.

Because large databases often provide too much of a good thing, approaches based on Query and OLAP usually encounter a problem known as "The maze of a million graphs" – a user can build a million pie charts and yet not see the forest for the trees because there is so much data. Data mining, on the other hand, draws its power from the ability to search through the data with its own initiative, discovering key patterns by itself.

Although the three approaches above are useful, they share a common trait in that the user has to perform analysis to gain knowledge, this is called the Data Analysis Paradigm. A morel and unique approach to empowering business users with refined information is the Knowledge Access Paradigm pioneered by Information Discovery. With the knowledge access paradigm data analysis is performed beforehand and the user just looks up the premined knowledge on demand.

To distill information from a database we obviously need to perform analysis at some time. The key question is when. In other words, does the analysis takes place at the time the user needs the knowledge or is it done beforehand, with the knowledge ready to access? Traditionally, data mining analyses were performed upon user request. The knowledge access paradigm rescues users from delayed analyses by pre-mining refined knowledge. Hence there are two distinct paradigms for empowering users with knowledge:

- Data Analysis Paradigm

    In this users operate on data to discover information. This paradigm relies on the analysis on demand approach.

- Knowledge Access Paradigm:

  In this the analysis is automatically done beforehand, refined patterns are pre-generated and users just get knowledge when needed.

The knowledge access paradigm forever changes the game in favor of the business user. The user can just reach for refined knowledge when needed, without the need for analysis. Taking this a step further, the knowledge transfer system makes life even easier for the business user. There is no longer a need to even ask questions, all a business user does is interact with a web-based system that transfers knowledge to the user with its own initiative, determining what the user needs to know. It provides a multitude of benefits to the business user:

- Condensed Information

Because of disk space limitations, many organizations only store 12 or 24 month worth of historical data. However, because knowledge is so much more compact than data, the pattern – base is only a fraction of the size of the database, allowing many years worth of patterns to be stored with ease, even when the data is no longer available.

- Easy to Use, yet powerful

Business users without technical knowhow can access knowledge without training – they just click a graphic user interface from within a web-browser. And, the knowledge access approach is more powerful because multiple types of powerful patterns are automatically merged to answer serious questions.

- Fast Response and Overall Efficiency

When a user requests knowledge, no analysis is needed and following-up questions are answered quickly, without delay. Because patterns are not recomputed each time for each user, the overall system efficiency is much higher. Computations take place only once and users access the refined knowledge again and again.

- Accuracy and Quality

Because sampling and extract files are avoided, the discovered patterns correspond to the entire database and have high accuracy resulting in better decisions. And because patterns are stored in a single repository, all users get similar answers, rather than relying on fragmented analysis.

- Up-to-date Knowledge

Because the pattern-base is incrementally updated, recent patterns are always possible.

The knowledge access paradigm is a truly revolutionary idea with a multitude of business and technical benefits that reinforce each others. It will forever change the way you access your corporate knowledge.

GEOGRAPHICAL INFORMATION SYSTEM

Several years ago, telecommunications carrier GTE tracked the progress of its fibre-optic network by policy pins into maps handed out by a car rental agency. Today, Geographical Information System (GIS) provide a much more sophisticated way for companies such as GTE to gather a wide range of information and display it on computer generated maps.

Geographical information is one of the most important information. This is a vital component in decision making of a firm. A firm's venders, dealers, distributors, customers etc. are located all over the region. So there has to be some kind of software which makes it easy and efficient to manipulate the geographical data.

GIS always creates an usage of the software used for geographical surveys. But they are applicable to business and corporate world. GIS can be used in almost all the functioned areas of business.

GIS is a computer based system which stores, manipulate and retrieve the information related to graphical decisions of a company.

The number of business applications of GIS has grown significantly in the last few years. For example, Mobil Oil used a GIS product called Map Info for crisis management in the event of an oil spill or task explosion and levi strauss uses GIS to match stores product mix with customer demographics.

Therefore GIS is a very important tool used for information sharing between various departments on the basis raw material, etc. This geographical information utilized at the right time can lead to immense profits.

REVISION EXERCISES

1. Give a brief introduction to data warehousing.
2. Why does the use of a star schema or multidimensional / OLAP (On-line analytical processing) design for a data warehouse seriously compromises its value? How can one overcome the problems?
3. Why data warehousing sometimes can be an expensive preposition?
4. How can a data warehousing person can effectively understand the users requirement?
5. Explain the terms

(a) cleaning the data

(b) data definition

(c) strategic value of data warehouses

(d) data warehousing from ERP vendors

6. Explain briefly the important steps in approaching data warehousing?

7. What is the need for validation in data warehousing?

8. Prepare a project on data warehousing for the automobile industry.

9. What are the main reasons behind a Data warehouse failure?

10. Illustrate various steps involved in rejuvenating the data warehouse structure.

11. Explain the complexities and problems associated with data warehouse.

12. Define the Relationship between data warehousing and ERP concept.

13. Explain in detail the approach of data mining.

14. Why GIS is important from the corporate point of view?

15. What kind of Geographic Information would be an educational institution interested in?