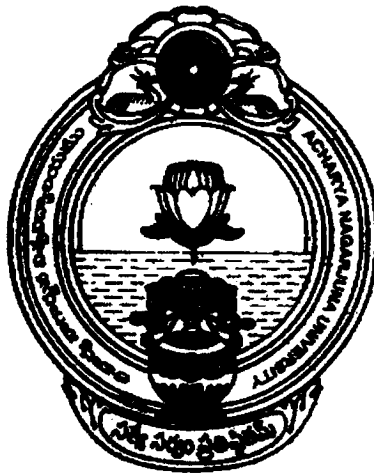# INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

M.B.A., 1st Year, & Excutive MBA I & II Year, Paper - VI

CENTRE FOR DISTANCE EDUCATION

Acharya Nagarjuna University

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M.B.A. Information Management and Computer Applications

FOREWORD

Since its establishment in 1976, Acharya Nagarjuna University has been forging ahead in the path of progress and dynamism, offering a variety of courses and research contributions. I am extremely happy that by gaining a B++ (80-85) grade from the NAAC in the year 2003, the Acharya Nagarjuna University is offering educational opportunities at the UG, PG levels apart from research degrees to students from over 285 affiliated colleges spread over the three districts of Guntur, Krishna and Prakasam.

The University has also started the Centre for Distance Education with the aim to bring higher education within reach of all. The centre will be a great help to those who cannot join in colleges, those who cannot afford the exorbitant fees as regular students, and even housewives desirous of pursuing higher studies. With the goal of brining education to the doorstep of all such people, Acharya Nagarjuna University has started offering B.A., and B.Com courses at the Degree level and M.A., M.Com., M.Sc., M.B.A., and L.L.M., courses at the PG level from the academic year 2003-2004 onwards.

To facilitate easier understanding by students studying through the distance mode, these self-instruction materials have been prepared by eminent and experienced teachers. The lessons have been drafted with great care and expertise in the stipulated time by these teachers. Constructive ideas and scholarly suggestions are welcome from students and teachers involved respectively. Such ideas will be incorporated for the greater efficacy of this distance mode of education. For clarification of doubts and feedback, weekly classes and contact classes will be arranged at the UG and PG levels respectively.

It is my aim that students getting higher education through the centre for Distance Education should improve their qualification, have better employment opportunities and in turn facilitate the country's progress. It is my fond desire that in the years to come, the Centre for Distance Education will go from strength to strength in the form of new courses and by catering to larger number of people. My congratulations to all the Directors, Academic Coordinators, Editors and Lesson-writers of the Centre who have helped in these endeavours.

Prof. P. Rajasekhar
Vice - Chancellor, FAC
Acharya Nagarjuna University

PAPER - VI : INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

SYLLABUS

Computers in Management: Role of Computers in Management – Introduction to Computers – Personal Computers and its uses – Spreadsheet Software and managerial Applications.

Managerial Applications of Computers: Computer and Management Functions – Computer Based Financial Systems – Computer Based Inventory Systems – Computers in Human Resource Management.

Socio-Legal Aspects of Computerisation: Social Dimensions of Computerisation – Computer Viruses – Legal Dimensions of Computerisation.

Management Information Systems: An MIS Perspective-Information Needs and its Economics – Management Information and Control Systems.

Systems Analysis and Computer Languages: Systems Analysis and Design – Computer Programming – Programming Language – COBOL and its Applications.

PAPER VI - INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours   Maximum : 75 marks

SECTION A - (3 x 5 = 15 marks)
Answer any THREE of the following.

1. a) Explain the block diagram of computers.

    b) What are social dimensions of computers?

    c) Discuss the properties of secondary storage devices.

    d) Define MIS and discuss elements in MIS.

    e) Draw the DFD diagram for payroll processing system.

    f) What are the different types of computer viruses?

SECTION B - (3 x 15 = 45 marks)
Answer any Three of the following.

2. Write about Evolution of computer technology with illustrations.

3. Explain computer based financial system.

4. Enumerate the uses of computers in efficient global Human Resource Management.

5. What are the methods of finding information needs of M/S and Explain the structure of M/S for any typical manufacturing organisation?

6. Write the steps in system analysis and design.

7. Explain the importance of cyber laws in computerizations.

SECTION C - (15 marks)

8.   An Outside system Analyst was asked by the bank's president to contact Mrs. Mandelbum about some problem in the accounting department, during the first meeting, Mrs. Mandelbaum, the Supervisor, said there have been problems reconstructing the Christmas Club account three out of five days each week. The tape shows figures that are either more or less than actual cash receipts. The head teller blames it on the old teller terminals, which are "down" most of the time. The accounting department counters by emphasising that the teller department is accountable for the difference. Everything points to human error.

        With this in mind, the analyst went straight to the teller in charge of the club account and pretty much accused her of stealing money. Following this meeting, he conducted interviews with the head teller and the reconcilling clerk in charge of the club accounts. Late that day, he phoned the president and told him it could take a week to correct the problem.

        The next day, the analyst studied the coupons and the procedure followed by the clerk. Although counting coupons was manual, there was nothing in particular to explain the difficulty in balancing receipts.

        During the next three days, the analyst observed the teller and how she handled the coupons, Everything seemed normal, although there were occasional errors in keying the amounts or code.

The last day was Friday and the analyst had no answers. The president was disappointed with the lack of feedback, when confronted, of accounting, auditing, or how accounts are reconciled, but if he had another week he could learn enough to computerise the whole operation.

Toward the end of the day, a customer's passbook was posted with the wrong amount. Upon closer inspection, it was found that the teller machine always printed 9 instead of 0. When the machine was replaced, the Christmas Club account balanced with no difficulty.

Assignment :

a) What mistakes did the analyst make in handling the project? Did he use a correct procedure? Explain.

b) What type of personality would it take to deal with a problem like the one just described? Why?

c) What qualifications do you suggest the analyst possess to handle this case? Why? Explain.

d) In deciding on an analyst, what criteria do you suggest the bank consider for future invitations? Elaborate.

PAPER VI - INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours   Maximum : 75 marks

SECTION A - (3 x5 = 15 marks)

Answer any Three of the following.

a) Principles of computer programming

b) Features of Spread sheet software.

c) Types of Personal Computers.

d) Management Information control systems.

e) Differentiate low level language and High level language.

f) Social implications of computerization.

SECTION B - (3 x 15 = 45 marks)

Answer any Three of the following.

2. Management Decision Making becomes effective with the good design of MIS to the organization, Illustrate.

3. Security in using computers is a complex issue in globalisation. Discuss.

4. Design the Cobol program for the inventory control system.

5. What are the steps in designing MIS for the organization?

6. Explain any three business application of spreadsheet software.

7. Write about the block diagram of the computers.

SECTION C (15 marks)

Case Study

8. A new on-line teller system design for a medium size bank was approved by the President, signalling the beginning of implementation. The project leader devised a master plan to specify who is perform each task and in what order. New deposit and withdrawal slips were ordered and delivered three weeks before implementation. In the interim, copies of the user manual were prepared for the lobby and drive-in-tellers.

Soon after the terminals were installed, the tellers began to learn how to enter various transactions. After training sessions were over, they had a chance to ask questions and inquire about the new system. Once completed, the telephone company and the computer service representative hooked up the terminal on-line with the master system.

The following Monday (a week before actual conversion), the analyst asked the head teller whether the tellers would come in on Saturday to catch up on their work and run test data to reinforce recent training. The head teller agreed to the overtime, but on Saturday,

only 12 of 17 tellers showed up. During that time, the entire system was checked out and functioned as expected.

The bank opened the following Monday, the on-line system operated normally. Customers were greeded at the door by the president. Coffee and cake were served in the lobby. As the end of the day, the analyst sent a report to the board of directors, informing them that the system was now in operation and all user requirements had been met.

Three weeks later, the analyst was called to the board meeting. The Chairman criticised the analyst for exceeding the budgeted amount approved by the board. Further more, the authorization the analyst gave the terminal vector to bring in two CRT screens to expedite information retrieval exceeded his authority to implement the system. The bank's auditor also estimated it would take 3.8 years rather than the initial estimate of 2.1 Years to break even on the total cost of the installation. Not knowing what to say, the analyst left the board room with a feeling of total failure.

Answer the following :

    a) What are the major problems in the case? Who is to blame? Why?

    b) Was the board Chairman justified in his criticism of the analyst? Explain.

    c) Where did the analyst fail in handling implementation? Be specific.

INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

CONTENTS

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BLOCK 1   COMPUTERS IN MANAGEMENT

This block attempts to give you an understanding of a computer and its diverse applications in management.

First unit introduces you to the role of computer-aided decision-making in management of an organisation through proper handling of information system, and its advantages and limitations.

Unit 2 discusses the evolution of computers and then its components i.e.. Hardware and Software. It also gives an idea about the classification of computers.

Unit 3 deals with phenomenal growth of micro-computers. It is followed by an explanation of a typical micro-computer, its hardware and the most common personal computer applications. Major types of software used for management applications are then described.

Fourth and the last unit of this block begins with a description of the basic concept of a Spreadsheet. It then discusses features of a specific Spreadsheet package called LOTUS 1-2-3 and how problems can be solved/modelled using this software package. The capability of modelling and sensitivity analysis are exemplified through an illustration. The major features are listed and a few important ones are explained. Some advantages of using Spreadsheet package are then highlighted.

UNIT 1 ROLE OF COMPUTERS IN MANAGEMENT

Objectives

After going through this unit you should be able to:

* appreciate the significance of computerisation for efficient management decision-making at the corporate level ·

* understand the role of Computer-aided decision-making in management of an organisation and advantages and limitations thereof.

Structure

1.1 Introduction

1.2 Need of Information Handling

1.3 Levels of Information Handling

1.4 Advantages of Computerisation

1.5 Approach to Computerisation

1.6 Strategic issues of Computer-aided Decision-making

1.7 Summary

1.8 Self-assessment Exercises

1.1 INTRODUCTION

Prof. H. A. Simon views the computer as the fourth great breakthrough in history to aid man in his thinking process and decision-making ability. The first was the invention of writing which gave man a memory in performing mental tasks. The remaining two events prior to the computer were the devising of the Arabic number system with its zero and positional notation. and the invention of analytic geometry and calculus, which permitted the solution of complex problems in scientific theory. Now the electronic digital computers combine the advantages and attributes of all these breakthroughs and make them available for decision-making and management of organisations.

1.2 NEED OF INFORMATION HANDLING

Management Information System (MIS) can be defined. according to Joel E Ross, as a communication process wherein information (input) is recorded. stored. processed and retrieved for decisions (output) regarding the managerial process of planning. organising and controlling: If we now define decision-making as the process of selecting from among alternatives a course of action to achieve an objective, the link between information and decisions becomes clear. Indeed, decision-making and information processing are so inter-dependent that they become inseparable. if not identical, in practice.

Computerised MIS cannot technically make a decision but it can yield processed data and follow instructions to the extent of its capacity. For example, the computer can be properly

instructed to compare inventory levels with programmed decision-rules on re-order level and re-order quantity, and generate purchase requisition, purchase enquiry and purchase order. This can resemble an automatic control of purchase documents, as being done for TISCO (Tata Iron and Steel Co. Ltd.) over a long period.

The modern role of MIS for managerial decision-making in a complex organisation has been compared to that of a military commander. Commanders often adopt a strategy built by direct observation of partial situations. This is the style used by the managers who track operations by periodic communications with remote sales depots, plant divisions and other offices. For instance, the central marketing organisation of the Steel Authority of India Limited (SAIL) has to keep track of around 50 sales depots spread all over India for marketing decision-making.

1.3 LEVELS OF INFORMATION HANDLING

In a modern complex organisation, the levels of information handling can be divided as decision support system, management information system, transaction processing system, and office (and other) automation system.

At the apex, the top level managers may need decision support system (DSS). This would be an inter-active system that provides the user-manager with easy access to decision-making models and data in order to support semi-structured and non-structured decision-making tasks. Inputs for DSS can be some processed data, and mostly management-originated data along with some unique models. The DSS would involve queries and responses, operations research models, and simulation. The output from DSS would be special reports to resolve difficult questions and replies to management queries.

At the middle management level (if there exists one), MIS would deal with an organised set of procedures to provide information for middle managers to support their operations and decision-making within the organisation. At this level, inputs for MIS would be both processed and raw-data and some management-originated data, along with pre-programmed models. The MIS process would involve report generation data management, simple models and statistical methods. The outputs from MIS would be filtered and screened for semi-routine decisions and replies to simple management queries.

At the shop-floor management level, transaction processing system (TPS) is a computer-based system that would capture, classify, store, maintain, update and retrieve simple transaction data for record keeping and for feeding MIS and DSS. The TPS would have transaction data as inputs. The processing for TPS would involve classification, codification, sorting, merging, adding, deleting and updating. Outputs for TPS would be detailed reports relating to routine decisions and processed data.

At the clerical level, office and other automation control system can be in operation. Office automation system (OAS) is simple in an automated office having multiple functions, where the integrated and computer-aided system allows many office activities to be performed with electronic equipment. The OAS would have inputs such as appointments, documents, addresses, etc. The OAS processing would be scheduling word-processor, data storage and retrieval. Outputs from OAS would be schedules, memoranda, bulk mail and administrative reports.

Here we would mainly be concerned with MIS at the corporate level.

Activity A

Prepare a brief report on the extent of Decision Support, Transaction Processing and Office Automation Systems, prevailing in your organisation, in context of the description given above.

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1.4 ADVANTAGES OF COMPUTERISATION

The advantages associated with computer-based managerial decision-making can be the following: (1) response time is greatly reduced; (2) very large data are stored for information and decision-making; (3) accuracy of information is considerably improved, thereby improving the quality of the decision; (4) problems are handled more easily by using various operation research models; (5) the cost involved in the decision-making process is reduced; (6) more secrecy is observed as compared to manual file system; (7) ability to take quick decision improves considerably as the time for retrieval of information is very fast; (8) paper work is reduced to the minimum as all the information is stored in the computer itself; (9) lots of information are stored for future reference; (10) chances of leakage of classified information are reduced; (11) accuracy in manipulation is increased very much; and (12) time spent in various decision-making activities is reduced to a minimum.

Emanating from the above, the following benefits for a commercial organisation can be attributed to computerisation: (1) the availability of accurate forecasts within 1 per cent of net income; (2) the preparation of short-term profit plans and long-term projection; (3) the provision of pre-plan information in budget preparation; (4) the calculation of variances between budgeted and actual results; (5) the triggering of revised forecasts if not proceeding in accordance with plans; (6) the early warning system for monitoring activities and the signalling of necessary reactive plans; (7) the indication of income and cash flow by following alternate investment strategies; (8) the assistance to the planning of new facilities and a host of special strides; and (9) the accomplishment of the preceding items at a great speed.

While TPS has been in use over several decades, OAS is coming into practice only now in a number of organisations. The TPS has brought its own benefits for speedy execution, accurate performance and quite often confidential handling. Such benefits will become evident if one considers a couple of very common TPS applications.

The first is examination result processing which the bulk of Indian universities are doing on computer today, either with inhouse systems or with hired service bureaus. The massive nature of such processing can be visualised by looking at one State alone, namely, U.P., where 13 lakh candidates go through high school stream and 6 lakhs through the intermediate stream in any single year. The processing and publication of their results in time would not have been possible

without computerisation. Besides, it is possible to maintain some confidentiality on computer processing. Another application is computerised electricity billing adopted by several State Electricity Boards in India. Under the computerised system, every meter for light and fan, or for power is invariably supported by a billing raised by computer and every such bill is again invariably despatched by computer centre. Both these actions guarantee improvement over the manual system where there is usually little certainty of bills being raised or being actually despatched due to adoption of foul means. In a single State undertaking like SPSEB it was estimated that the computerisation in the Western U.P. district for electricity billing had resulted in a considerable amount of additional revenue.

Advantages of MIS can be manifold because of the aid to higher level decision-making. Once the planning, monitoring, reviewing and control process are facilitated, the benefits can literally multiply several times, over and above the mere shop-floor or clerical TPS applications.

Activity B

Based on the various uses of transaction processing system in different organisations for speedy and accurate execution, suggest some other uses, which may be taken up by your organisation

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1.5 APPROACH TO COMPUTERISATION

The first important stage to organising MIS at the corporate level is to build up comprehensive data-base from the clerical systems. Valid data should be initially classified and codes attached to each data-set. Thereafter data-base should be constantly updated. The analogy to a reference library system is almost uncanny, where books have to be classified according to the subjects (e.g. reference, economics, management, etc.) and then codes attached to each book (e.g. 001 for reference, 338 for economics, 658 for management, etc.). Thereafter the books need constant updating through cataloguing and indexing. A library, however, is not as amenable to easy cross-reference among a vast number of books, as a computerised data-base is. With classification, codification and updating, a computerised data-base can help the user with almost instant retrieval of any amount of cross-classified and cross-revised data, thus helping tremendously the decision-making process.

The second important stage to MIS at corporate level is to decide on the principles of evaluating the raw data for decision-making. For this purpose, the four principles that can be unhesitatingly recommended are: selection, pattern, linkage and overview. The first principle of selection looks at a screened segment of data which can focus attention on variances from standards, deviations from norms, fluctuations from targets and differences from budgets. It is presumed that whatever data are related to the initially fixed standards, norms, targets and budgets they are, to that extent, not required to be looked at any further. But whatever are not conforming to the steady state are worth looking at for decision-making purposes. The second principle of pattern is to look at the collection of data and to derive insight by virtue of management ratios,

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trends, correlations and forecasts. Essentially this is a principle of gaining insight into the given mass of data. The third principle of linkage is a way of looking at a number of widely dispersed data-sets and to formulate a coherent picture. The last principle of overview is to derive a total picture which cuts across a number of control parameters and sums up the managerial position.

The third stage of MIS at corporate level is to realise the above four principles in actual practice. The first principle of selection can be implemented by generating exception-based reports. This requires the safe-keeping of classified, codified and updated data on the computer and retrieving only specially meaningful reports on the basis of exception. The second principle of pattern can be implemented by using mathematical modelling and statistical analysis. Such analytical approach requires the data-sets to be treated with mathematical models and statistical methods in order to derive meaningful indicators for decision-making.

The third principle of linkage can be implemented by inter-relating different data-sets from disparate files or data-bases. The inter-relationships would provide again available insight across the board. The fourth principle of overview can be implemented by aggregating data. Such a process of aggregation can connect together the classified and codified data for purposes of deriving a managerial insight into the total span of operations.

1.6. STRATEGIC ISSUES OF COMPUTER-AIDED DECISION-MAKING

Transaction processing system using computers have played a relatively limited role as a management tool. This has been so because decision-making has not been their central theme. Instead, they have been specially-oriented for on-going clerical needs in personnel (pay roll), book-keeping (accounting), technical data (capital projects) or specific functional areas (materials). Alternatively, they have been project-oriented, used to manage a specific programme of limited time and scope, such as, examination result processing, or, they have been problem-oriented for emergency and random retrieval of information to meet a crisis situation of limited duration and scope, such as, coal-blend analysis for the incoming coal wagons with varying ash and volatile content for all the steel plants.

According to Robert Anderson, the coporate MIS should assist such material functions as (a) manufacturing, marketing and other real-time operations; (b) futuristic improvement and problem-solving, instead of historical reports of the past actions; (c) necessary corrective action rather than book-keeping; and (d) monitoring of outside conditions affecting the organisational plans.

Joel E. Ross identifies the reasons for corporate MIS as the same for planning in general. It should offset uncertainty, improve economy of operations, focus on the objectives and provide a device for control of operations. Such an approach is radically different from the patch-work approach of the transaction processing system. What follows is identification of some of the strategic issues identified by Ross and others, and their suggested solutions in the Indian context.

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Communication Gap

One of the reasons for the over-emphasis on the transaction processing system is the communication gap between the computer professional and the user-manager of the system. In India, far too many organisations have become used to separate EDP departments, now increasingly called computer services departments. According to Robert Townsend, the computer professionals keep on "trying to make it look tough, which is not easy. They are building a mystique priesthood, a trend of mumbo-jumbo ritual to keep you from knowing what they are doing". Because of the training interest and peer pressure, Ross suggests that there is a compulsive tendency for the computer professional to generate massive data-bases, to install display devices and glittering data-communications techniques, and to install newer and grander design. This phenomenon is quite common in India and only serves the purpose of empirebuilding and not improved management.

There is a familiar situation where the computer professional is engaged in developing the computer-aided decision-making but is not able to communicate to the user-manager. The information that he needs is called for, but the user cannot adequately express them as he has not been accustomed to a rigorous self-analysis. Thereafter, the computer professional works out a plan based on his own understanding of the user-needs, to convert them into the flow-charts and programming. In the process, the information needs themselves get altered. When the programmer codifies and implements the system, his own interpretation gets incorporated, thus further changing the user-needs. All these end up by frustrating the user-manager. This can be called "ten-minute syndrome" where sufficient time has not been spent between the user-manager and the computer professional to get all the needs clearly conveyed and understood.

A situation arose where during examination processing grace marks had to be allocated by way of moderation. Computer professionals allocated grace marks to all students which resulted in glaring anomalies where some top ranking students secured more than 100 per cent marks by virtue of additional grace marks. Obviously, the Controller of Examination had not explained properly the mystique of grace marks to the computer professionals!

Reliance on Service Bureaus or Computer Vendors

Quite often, Indian user-manager is approached by computer vendor who brain washes the management into buying his system, indicating that the system has all the solutions to the managerial problems. The end-result is that either the user gets a system which is too large for him with a lot of computer "fat" or he gets inadequate computing power for his needs.

Ross suggests that there should not be any technical romance with the computer vendor but a return on investment (ROI) approach to expenditure. Further, the user-manager should operate with master plan, rather than react to the vendor's suggestions. There have been cases where an organisation had appointed a service bureau for a large sum of money to develop a corporate MIS. After spending an year as well as a couple of lakhs of rupees, the user-organisation was thoroughly dissatisfied with the recommendations of the service bureau and did not implement it.

Lack of Master Plan

The bulk of computer failures are due to the lack of master plans to which hardware acquisition, software development and individual MIS design can be related. Without such a plan, "islands of mechanisation" result with little integration between separate systems.

The TISCO studied the interface of various systems like production planning and control system, financial control system, and sales invoicing and order processing system. It was observed that if individual systems were developed without regard to their mutual interfaces, the result would be an absence of communication between the systems and the incompatibility of the systems would prevail throughout the company. This was prevented by building up sufficient linkages among these systems and developing an integrated approach according to a master plan. A similar approach was also adopted by TELCO with encouraging results.

Organisation of the MIS Function

Since clerical systems came first involving accounting, pay roll, inventory returns and similar financial jobs, the transaction processing system developed around all of them. Following the normal principle of assigning a service activity by "familiarity", the historical trend in India has been to assign the computer to the Controller of Finance or Chief Accountant. This has been the case in the TISCO, TELCO, Indian Railways and elsewhere. Only now the situation is being reversed and in HAL, BHEL etc., MIS function has been placed under the user-manager.

With more distributed processing becoming possible, the trend has been to place computer-aided decision-making where it belongs, mainly under the user-manager with his own computing power. Already, the personal computers (PCs) have made this trend possible in practice, with individual data-bases available to the users. Similarly, terminals are available to most important users to share central computing power. In both cases, all PCs as well as terminals, the control of the computer-aided activity has to remain with the user-manager.

Lack of Good Management System

It is imperative for successful corporate MIS on computer that there is good planning and control within the framework of an efficient organisational structure. No degree of sophistication with computers can cure the basic ill of chaotic data management.

There have been many organisations where computerisation has not brought any tangible improvements because there has been no systematic handling of data or attention paid to the data management. In such cases, there would have been considerable gain by first conducting a good Organisation and Method (O&M) study. MIS has to be built on top by a management system which should include the organisational arrangements, the structure and procedures for adequate planning and control, the clear establishment of objective, and all other manifestations of good organisation in management

It is interesting to note that good computer professionals know their craft but are simply oriented to managerial jobs. In other words, the broad-based skills, which are necessary to function both in the computer room and in meeting with user-manager for the MIS, are conspicuous by their absence. This phenomenon has been known globally and that is why computer professionals are often called 'machine-mesmerised', where they are more loyal to their profession than to their organisation!

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Managerial Participation

The single most critical problem in effective computer utilisation is the need for understanding and support from top management. In a State like Andhra Pradesh, the Chief Minister's personal encouragement has paved the way to bring computerised MIS gradually to all the districts, apart from their wide-spread use in State departments and in the Secretariat.

Even after top management support is ensured, it is necessary that there is user participation in the design phase on corporate MIS so as to avoid subsequent extensive and time-consuming re-work. This can be called "overnight syndrome" where users spell out their needs and expect the computer professionals to deliver the outputs immediately thereafter. Converting jobs eventually for computerisation needs a stabilisation period, which is all too easily forgotten.

An example of the above is the case of Uttar Pradesh State Electricity Board which went for computerised electricity billing for the Western districts. In the design phase, the Board authorities dictated that only Agra and Ghaziabad should have a pilot project before its extension to all other districts. Also, manual financial ledgers would continue as a parallel run alongwith the computerised financial ledgers for at least two billing cycles so as to generate enough confidence in the computerised ledgers. The result was a smooth introduction of computerisation. On the other hand, another State Electricity Board went through a similar computerisation process without the benefit of any pilot project or parallel run on the grounds that the results were needed fast and they were spending money on computers in any case. The consequence was a disaster when many erroneous bills came and in some cases none at all. There were questions in the Parliament and an enquiry committee under the Central Electricity Authority had to investigate the mistakes. The result was to cancel the existing computerisation, to start de novo, after having spent several lakhs of rupees which went waste.

It makes good sense, as has been experienced in the NTPC, when the user-manager picks up a minimum familiarity with the MIS at the beginning. From the point of view of the organisation, corporate MIS is as much a vital part of the operation as marketing operations and finance are today. Indian Airlines, too, discovered that managers had to be involved in order to get better and more effective information systems by virtue of their participation. A similar approach is being followed in LIC.

Failure to Identify Information Needs

A clear identification of information needs is fundamental and necessary to go for design of a corporate MIS. Recently, a Central Government department spent lavish sums on hardware and software to perpetuate the existing 53 MIS reports and to build a sophisticated data-bank without first determining the real information needs of management. It is often forgotten that only that information should go into the corporate MIS which can increase the perception of managers in critical areas such as problems, alternatives, opportunities and plans.

At least there have been two States in India which built up comprehensive land-record data-banks without examining what the user needed from these data-banks. The enormous costs for building their data-banks were later found to be unjustified and both these States have since discontinued their efforts in this area. On the other hand, another State (Uttar Pradesh) has begun on a limited basis to build up corporate MIS for 200 parameters for a couple of districts and, after ascertaining the user-needs, it is proposed to extend the MIS further to all the districts.

It is the user-manager who is to provide the specification for what he wants out of his corporate MIS. If the manager fails to do so, the computer professional by default would provide his own objectives and his own information needs. These would seldom meet the needs of the user-manager.

Poor Systems Prior to Computerisation

It has been observed that computerisations of a poor system will merely increase inefficiency at an accelerating rate. The user-manager gets irrelevant or bad information faster and the bad decisions are made sooner!

Hindustan Zinc Ltd., for instance, planned to upgrade and improve their transaction-processing system in a methodical manner. Such clerical systems as ledger accounting were to be upgraded to financial planning; invoicing to sales analysis; inventory accounting to inventory management; and production reports to production planning and control. Well established procedures helped them to make a smooth transition.

Overlooking Human Acceptance

A new MIS quite often meets resistance from the user-organisation because people do not accept what they do not understand. Such reasons for resistance have to be analysed and a new attitude brought into overcome it. Ross identified the reasons as threat to the status of the salesmen; threat to the ego of the managers; economic threat to the clerical persons (fear of job loss), insecurity for the managers having personal powers and political base; loss of autonomy and control for the production managers and engineers; and frayed and inter-personal relations for all others.

A number of public and private sector organisations such as BHEL, Hindustan Zinc Ltd., NTPC, Bhadrachalam Paper Board, etc. have started a process of systematic programme of training and user-education. It is imperative that such education begins at the top level for computer appreciation, at the middle management for specific computer applications in their own domains, and at the working level for direct involvement in input and output quality control. It is good to see the bulk of Indian organisations going through such an elaborate process of computer initiation as there is no short-cut to it.

Activity C

Go through the text in para 1.6, recall some of your own experiences and comments based thereon.

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1.7 SUMMARY

We have given a brief account of a purposive way of using computer as a management tool. There are two eloquent reasons why such a tool is more feasible to operate today than ever before. The first reason is that computing power in any organisation is becoming increasingly available on a distributed basis through an array of terminals and/or through desk-top computers available for personal use. Availability of both terminals and personal computer is almost a common phenomenon today.

The second reason is that the computers were used to be driven earlier by the professionals and were housed exclusively in the EDP departments. From that atmosphere, the computers have currently become very much user-friendly when the barriers of EDP department have broken down and computer languages are becoming more and more English-like. From this stage on, it is very likely that computers would show a trend to become user-driven. Thus, the transition from professional-driven to user-friendly to user-driven is a near reality now!

Further we have described some of the strategic issues which have bedevilled introduction of computer-aided decision-making in the forms of corporate MIS in many organisations in India and abroad. Some general principles have been used to illustrate the situation and a number of Indian examples have been cited by way of deriving appropriate lessons. It is vital to keep reviewing the situation so that such strategic issues are not lost hight of in the country's current emphasis on computerisation. It is important to avoid frustration before one aims at achieving elation on successful computerisation!

1.8 SELF-ASSESSMENT EXERCISES

1. Employees in modern Organisation are called 'knowledge workers'. Justify.

2. Handling of information provides the basic ingredient in the decision-making process. Explain.

UNIT 2 INTRODUCTION TO COMPUTERS

Objectives

The objectives of this unit are to understand:

- initially what actually a computer is and its evolution
- two major components of a computer system viz., Hardware and Software
- classification of computers.

Structure

2.1 EVOLUTION OF COMPUTERS

Computers have brought about a revolution in the field of computing as a result of technological advancement in the field of electronics.

"Abacus", the first mathematical device used to facilitate arithmetical computation, ... invented by the ancient Chinese before the birth of Christ. Abacus used beads strung of wires to aid arithmetical computations and is believed to have been in use till recently.

The first mechanical 'Computer' called 'Analytical Engine' designed by Charles Babbage betwee 1830 and 1850 marked the birth of computer age. This was the first mechanical computer capable of performing basic arithmetical functions. Charles Babbage designed his analytical engine around five components, namely,

a STORE to hold numbers,

an ARITHMETIC UNIT (which he called the 'Mill') to perform arithmetical operations,

a CONTROL UNIT to control and coordinate various activities in the correct sequence,

an INPUT device to transfer both numbers and instructions into the computer, and

an OUTPUT device to display the results of computations.

Remarkably even today's computers are built around the same concepts. However, modern electronic computers provide three major advantages:

- enabling the computer to operate at electronic speeds (an electron travels approximately 1 foot in 1 billionth of a second),
- providing tremendous reliability,
- making the computer a general purpose machine.

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The first commercial computer called UNIVAC (Universal Automatic Computer) using vacuum tube circuits was used by the U.S. Census Bureau in 1951. Computers using vacuum tube circuits belonged to **First Generation Computers**. Invention of the transistor by Bell Labs in U.S.A. gave birth to **Second Generation Computers** which used transistors instead of vacuum tubes. An example of a Second Generation Computer is the IBM 1401. **Third Generation Computers** were introduced in the mid-1960s with the invention of tiny integrated circuits on silicon chips. IBM released its 360 series computers with integrated chips of 28/1000 each sq. carrying more than 1000 circuits. Large scale integrated chips became available in 1969. Computers which used large scale integrated chips can be be called **Fourth Generation Computers** even though there is no general agreement on what constitutes a Fourth Generation Computer.

Invention of the micro-processor in 1972 has changed the computing scene dramatically. A micro-processor when interfaced with memory and input/output units becomes a micro-computer. A micro-computer is very small in size (can be actually placed on a table top) but is very powerful and provides a user-friendly atmosphere for managers to interact with it. The first business micro-computer called APPLE II was released in U.S.A. in 1977. A micro-computer which is reasonably powerful can be bought today for as low as Rs. 20,000.

Recent advances in the field of artificial intelligence are being used to design a "thinking computer". These computers can be called **Fifth Generation Computers**. A special feature anticipated in these computers is their ability to respond to spoken words. These computers are expected to be in the market by the end of this decade.

Activity A
Describe briefly 'generation of computers'. Find out which generation of computer, your organisation has, in case these computers are there in your organisation.

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2.2. COMPUTER HARDWARE

Physical units of computer system constitutes a computer's hardware. When you look at a computer system you are actually looking at the computer hardware.

A computer, like the human brain, receives information, stores it, processes it, and displays results. A computer receives information from **input devices**, stores it in **memory**, processes this information in the **central processing unit** and displays the results of processing in a useful form through **output** devices. A computer's memory like the human's is limited. Hence it stores most critical information in its **main memory** and less critical and less frequently used information in its **secondary memory**. Below we describe each of these parts in detail.

Central Processing Unit

The Central processing unit is the most important component of a computer's hardware. It could even be called 'the computer' by itself. It has an **arithmetic logic unit (ALU)** and a **control unit.**

The ALU, as the name indicates, performs all the arithmetical and logical operations. Examples of arithmetical operations are: addition, division, multiplication, etc. Examples of logical operations are: (1) Is A = B, where A and B are both numeric/alphanumeric? (2) Is a given character equal to M for male or F for female?, etc. All the arithmetical and logical operations are performed in the CPU in special storage areas called **registers.** The size of the register is a very important consideration in determining the speed of processing. Register size refers to the amount of information that can be held in a register at a time for processing. The larger the register size, the faster will be the speed of processing. A CPU's processing power is measured in million instructions per second (MIPS). The speed of CPU was measured in milliseconds (one 1000th of a second) on first generation computers, in micro-seconds (one millionth of a second) on second generation computers, in nano-seconds (one billionth of a second) on third and fourth generation computers, and is expected to be measured in pico-seconds (one 1000th of a nano-second) in the future fifth generation computers.

The control unit, as the name indicates, control and co-ordinates all the operations of a CPU. It ensures that the required information is transferred between the main memory, the arithmetic logic unit, input devices and output devices in the required and desired sequence. It also contains the logic circuits and storage needed for the control of multiple input and output devices. When a programme begins an input operation, the control unit identifies the input devices and sets up electronic data path for the data and instructions to enter the CPU. Subsequently the control unit executes the various operations in CPU in the desired manner. Upon completion of a job, the control unit identifies the required output devices and sets up data paths for supplying the output information to the desired output devices.

Main Memory

Main memory stores a variety of critical information required for processing by the CPU. Just how does it store information?

A computer works by electricity. Hence a binary number system which uses only two digits, namely, 0 and 1 is a very convenient way to represent information inside a computer. We could use the symbol 1 to represent the presence of an electrical pulse and the symbol 0 to represent the absence of it. Information in a computer consists of data (numerial and non-numerical) and instructions which are made up of a large number of characters, namely, decimal numbers 0 to 9, alphabets A to Z, arithmetical operators like (+), (-), etc., relational operators like (=), (<), etc., and many other special characters like (,), (;), etc.

With two binary digits, we can represent four different characters, namely, 00, 10, 01 and 11. With three digits we can represent eight different characters, namely, 000, 100, 010, 001, 110, 101, 011 and 111. Computers use eight binary digits (bits) to represent information internally. This allows upto $2^8 = 256$ different characters to be represented uniquely. A collection of eight bits is called a byte. One byte is used to represent one character internally. Most computers use two bytes or four bytes to represent numbers (positive and negative) internally.

The memory unit stores all the information in memory cells, also called **memory locations**, in binary digits. Each memory location has a unique **address**. The contents of the desired memory locations are provided to the central processing unit by referring to the address of the memory location. The amount of information that can be held in the main memory is known as **memory capacity**. The capacity of the main memory is measured in kilo bytes (KB) or mega bytes (MB). One kilo byte stands for 2^{10} which is approximately 1000 bytes. A mega byte stands for 2^{20} which is approximately one million bytes.

Earlier computers used **magnetic core memory**. However all modern computers use **semiconductor memory**. Semi-conductor memory is faster and cheaper than magnetic core memory. Semi-conductor memory is also available in a small board. These characteristics have made semi-conductor memory more popular and attractive. The only drawback of semiconductor memory is that it is **volatile**, that is it loses its contents in the event of power failure. However, it is not a serious drawback and can be easily overcome by having back-up power units.

Semi-conductor memory is known as **RAM** (Random Access Memory). This means that any part of the memory can be accessed for reading and writing. A magnetic core memory is also a random access memory. However the terminology RAM has been used in the literature with the invention of semi-conductor memory. Another part of main memory is **ROM**, (Read Only Memory) ROM allows its contents to be **read only** and does not allow users to store their programmes. Usually ROM contains utility programmes supplied by the manufacturers frequently used by the users.

RAM capacity is a useful indicator to compare the main memory capacity of various computers. Earlier computers, provided a memory capacity of 16 KB, but a memory capacity of 512 KB is very common in today's micro-computers.

Secondary Memory

Secondary memory is essential to any computer system because of the limited main memory. There are two types of secondary memory available, **serial access memory** and **random access memory**. A serial access memory provides only a serial access to retrieve information stored in it. A random access memory provides a random access to retrieve information stored in it. It is helpful to think in terms of a cassette tape providing serial access memory and a LP record providing a random access memory. Computers use magnetic tapes to provide serial access memory and magnetic disks to provide random access memory.

Magnetic Tape

A magnetic tape is a very compact medium for storing a large amount of data. A standard tape reel is 2400 feet long, 1/2 inch wide and can store up to anywhere from 20 MB to 150 MB

depending on the recording density it permits. A magnetic tape is mounted on a tape drive which has a read/write head.

The density of a magnetic tape refers to the amount of information stored in one inch of its tape length and is measured in bits per inch (bpi). Standard tapes come with 800 bpi or 1600 bpi, even though tapes with 6250 bpi are also common. A text book of 600 pages with 50 lines per page and 40 letters per line can be accommodated in less than 20 feet of a tape of density 6250 bpi. Imagine how much data can be stored in a 2400 feet tape?

The major advantages of a tape is its economical storage of large volumes of data and a quick transfer of its contents to CPU. However it has a major disadvantage namely it permits only a serial access of data. This is because the read/write head is fixed and immovable. As a result the tape has to be moved physically over the read/write head till we come to the desired location to access the required data.

Magnetic Disk

Magnetic disk was invented to overcome the sequential processing requirement of magnetic tape data. It is helpful to visualise a magnetic disk as a LP record. An access mechanism moves the read/write head to the desired surface on the disk to provide random access of data. A disk pack is a collection of individual disks stored vertically one atop the other and mounted on a disk drive. The disk drive rotates the disk pack at a constant speed. There is enough room in between the spinning disks to allow access arms with read/write heads to move to any storage location. Each disk in a disk pack has two recording surfaces, except the first and last disks which have only one recording surface. Thus a disk pack with 10 disks provides 18 recording surfaces. Such a disk pack also has 9 access arms. Each access arm supports two read/write heads, one read/write head to access the lower recording surface of the top disk and the other read/write head to access the upper recording surface of the bottom disk. Each recording surface is divided into a series of concentric circles called tracks and each track is further divided into sectors. The capacity of each sector whether it is on the inner most track or outer most track is a constant. One important characteristic of a disk drive is the access time which represents the time needed to access the desired record from a disk. Access time consists of two components, namely, seek time and rotational delay. Seek time represents the time required to seek the desired track on the desired recording surface. This involves a movement of the access arm, which supports the read/write head. Rotational delay represents the time required for the rotating disk to position the desired sector under the read/write head. Access time is measured in milli seconds. An average seek time of 25 milli seconds and an average rotational delay of 10 milli seconds resulting in an average access time of 35 milli seconds are common. Disk packs are classified into three types, namely, removable disks, fixed disks and winchester disks.

A removable disk pack, as the name indicates, can be trasported and replaced. A fixed disk pack on the other hand, cannot be removed or transported or replaced. However, it provides a quicker access time. A disk storage capacity of 600-1000 MB is very common. Winchester disks are a special type of hard disks and are supported mainly by micro-computers. A winchester disk provides a storage capacity in the range of 10 MB - 80 MB.

Diskettes and winchester disks provide random access memory on micro-computers. A diskette is a smaller disk of 51/4 inch in diameter. It provides a storage capacity of 360 KB and an average access time of 180 milli seconds.

Input and Output Devices

The input or output units of a computer system establish the communication between the system and its users. A large number of input and output units are available in the market. A few of them are discussed in this note.

Punched card is the most ancient (few decades old) input medium. Instruction and data punched on cards are transmitted into a computer through a card reader. A printed card has survived a whole century because of its simplicity. But it is on its way out now. Punched cards are being replaced by terminals which provide direct data entry.

Terminals have become very popular interactive input and output units. A terminal, when connected to a CPU, sends data and instructions directly into the computer. Terminals can be classified into two types, namely, hard copy terminals and soft copy terminals. A hard copy terminal provides a print out on paper whereas a soft copy terminal provides a visual display on a screen. A soft copy terminal is also known as a CRT (Cathode Ray Tube) terminal.

Key-to-tape, key-to-disk and key-to-diskette are stand alone data entry stations. These units usually have a small processor attached to a key board and a visual display unit. The processor checks for the accuracy of data at the time of entry. The screen displays what is being entered. These facilities are highly desirable for a data processing centre. Hence most of the data processing centres are switching over from punched card input to data entry stations.

A graphic display terminal displays information in both character and graphic forms. These are extensively used for CAD/CAM (computer aided design/computer aided manufacture) applications.

A plotter is used to obtain printed copies of graphic outputs. It is used by architects and designers to produce blueprints of their design on paper.

Printers are purely output devices. Printers are classified into line printers and dot matrix printers. A line printer prints one line of information simultaneously, whereas a dot matrix printer prints one character at a time. A dot matrix printer uses a 5 X 7 or 7 X 9 dot matrix formation to represent each character. Dot matrix printers therefore provide a broken appearance to the characters, whereas a line printer provides a better quality output. A line printer has a speed of about 2000 lines per minute whereas a dot matrix printer has a lower speed of approximately 100 characters per second.

Daisy wheel printers and letter quality printers are also character printers. But they produce excellent quality output. However, they are more expensive and slower than dot matrix printers. All the printers discussed so far are called impact printers as they make physical contact with paper while printing. A nonimpact printer on the other hand transfers information to paper without any physical contact. Examples of nonimpact printers are laser printers, xerographic printers, electrostatic printers, etc.

Most recent trend for data input is towards source data automation. The equipments used for source data automation capture data as a by-product of a business activity thereby completed eliminating manual input of data. Some examples are:

1. Magnetic ink character recognition devices are used by the banking industry to read the account numbers on cheques directly and do the necessary processing.

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2. **Optical mark recognition devices** can sense marks on computer readable papers. This kind of device is used by academic and testing institutions to grade aptitude tests where candidates mark the correct alternatives on a special sheet of paper. These answer sheets are then directly read by the optical mark recognition devices and the information sent to a computer for processing.

Activity B

Draw a flow diagram about functioning of computer Hardware.

2.3 COMPUTER SOFTWARE

Computer software consists of sets of programmed instructions which enable the hardware units to perform. Programming a computer to perform has always been a very difficult task. The first electronic computer was programmed using wired panels. Today's computers are programmed using software.

A computer software can be broadly classified into two categories - System Software and Application Software. System software is a set of instructions to the machine hardware to interpret and execute application software. An application software is a set of programming instructions for specific applications like payroll accounting, inventory control, etc. A system software consists of language translators (called compilers and interpreters), operating systems, utilities and special purpose software.

Language translators

A language translator is a system software which will translate a computer programme written by humans into a machine understandable form.

The most elemental form of programming uses only the binary digits 0, 1 which is directly understood by the electronic circuits. A programme written using only binary digits is called a machine language programme.

Assembly language provided a significant improvement over machine language. Assembly language programmes are written using mnemonic codes like ADD, STORE, etc. rather than their machine language representations in binary digits. Therefore, programming in assembly language is easier. However, it needs to be translated into machine language codes. This translation is done by an assembler. Both machine language and assembly language programmes are machine dependent. This means that a programme written for one machine cannot be used in another machine. High level languages, which are closer to English overcame the drawback of machine dependence. A few high level languages are FORTRAN, BASIC, PASCAL, COBOL etc. These languages relieve the programmers from being machine specific. However a programme written in a high level language needs to be translated into machine language codes before execution. This translation is done either through compilers or through interpreters. A compiler is a translator which reads an entire programme written in a high level language and converts it into machine language codes. An interpreter on the otherhand, is a translator which interprets statement by statement, any programme written in a high level language. An interpreter is a very effective tool for programme development as it checks for errors statement by statement in an interactive mode. This allows the programmer to correct the errors statement by statement as he enters them. A compiler on the otherhand, will request the user to enter the entire programming statement and then it will check for errors. Basic language provides a compiler and an interpreter. Other languages such as Fortran, Cobol and Pascal had only compilers initially. However, interpreters for these high level languages are also becoming available, partly due to the popularity enjoyed by micro-computers in the field of computing.

Operating Systems

An operating system is the most important system software and is required to operate a computer system. An operating system manages a computer's resources very effective, takes care of scheduling multiple jobs for execution and manages the flow of data and instructions between the input/output units and the main memory.

Operating systems became a part of computer software with the second generation computers. Since then operating systems have undergone several revisions and modifications in order to achieve a better utilisation of computer resources. Advances in the field of computer hardware have also helped the development of more efficient operating systems.

The first operating system called batch processing (serial) operating system was developed for the second generation computers. This operating system executes jobs serially one after another from a batch of jobs submitted for execution. The central processing unit is kept busy only during the processing cycle of a job and it idles during the input and output operations.

The above drawback of idling the CPU was overcome with the introduction of overlapped processing. For example why not take up input operation of job 2 and the output operation of job 1 simultaneously? This and similar considerations gave rise to the concept of multi-programming. A multi-programming operating system handles multiple jobs simultaneously by overlapping the input, output and processing cycles of various jobs.

This operating system was introduced along with third generation computers and is still very popular. It has replaced the earlier batch processing (serial) operating system. With multi-

programming a CPU's utilisation is increased and hence jobs get executed faster on an average. However a multi-programming operating system is more complex than a batch processing operating system and hence it requires more powerful hardware to support it.

Other types of operating systems which are popular today are **multi-processing** operating systems and **real time** operating systems. A multi-processing operating system uses multiple CPU's to process multiple jobs. A real time operating system is a very different type of operating system, because it is used for different type of applications, i.e., real time applications such as airlines reservations, process control, etc.

Utilities

Utility programmes are those which are very often requested by many application programmes. A few examples are:

1 SORT/MERGE for sorting large volumes of data and merging them into a single sorted list.
2 Transfer programmes for transforming contents from one medium to another, e.g., disk to tape, tape to disk, etc.

Special Purpose Software

Special purpose programmes are those intended to extend the capability of operating systems to provide specialised services to application programmes.

A few examples are:
1 Spreadsheet software like LOTUS, VISICALC etc.
2 Data Management software like dBASE III, DBMS etc.

2.4 CLASSIFICATION OF COMPUTERS

In the 1970s computers were classified into three categories, namely, super computers, large computers and mini computers. But the invention of the micro-processor which gave birth to micro-computers in the late 70s has drastically changed the computing scene. A wide range of computers are available today in the market ranging from a personal computer to a super computer.

A personal computer (PC) is a micro-computer which has its entire central processing unit on a single micro-processor chip. A PC provides a main memory capacity upto 640 kilo bytes and a processing power of 0.5 MIPS. It supports the use of 2 diskette drives of 360 KB each for random access secondary memory. A PC usually comes with a standard key board, a visual display unit and a dot matrix printer. It is usually operated by a single user.

A super micro-computer has its entire central processing unit on a very powerful micro-processor, provides a main memory capacity of upto 16 mega bytes, has a processing power of 2 to 3 MIPS, supports winchester disks of capacity 20 to 80 mega bytes and allows simultaneously access to multiple users. Today's super micro is actually replacing yesterday's mini computers which provide almost the same computing power if not less, but based on a different technology.

A large computer provides a main memory capacity of upto 32 mega bytes, a processing power of 10 MIPS and supports a large number of disks and tapes. Disk capacities range from 100 MB to 1000 MB. It also allows simultaneous access to multiple users and supports a large number of input and output devices.

A super computer is the largest computer system available in the market. It provides a main memory capacity of upto 64 mega bytes and a processing speed of 20 MIPS. It also supports a large number of disks and tapes of enormous capacity for providing random access and serial access secondary memory. A super computer also allows multiple users to interact with the CPU simultaneously through multiple types of input devices. It also provides outputs in a variety of forms and supports a large number of output devices.

Personal computers are used by managers for their own computing needs. Availability of a large number of user-friendly software packages on PCs have made them effective tools to support managerial decision-making. PCs have also encouraged distributed data processing. A super micro is used for commercial data processing and managerial applications. A large computer is necessary for very large data processing and data management applications. A super computer is primarily used for highly scientific and research purposes.

2.5 SUMMARY

This unit began with a brief commentary on the evolution of c mputers. We then discussed in detail the two major components of a computer system, vi.., Computer Hardware and Computer Software. A few important characteristics which measure the power of a computer's hardware and software have also been mentioned. Finally we provided a classification of computers ranging from a personal computer to a super computer.

2.6 SELF-STUDY EXERCISES

1   a)   What is computer hardware?

   b)   What is computer software?

   Mention two hardware and 2 Software components of a computer system.

2   Explain the following terms in one or two sentences each.

   a)   Central Processing Unit

   b)   Secondary Memory

   c)   Operating Systems

   d)   Language Translators

3   Explain the difference between Random Access Memory and Serial Access Memory.

4   Explain the advantages and disadvantages of Core Memory and ROM Memory.

5   Explain the distinction between a batch processing (serial) operating system and a multi-programming operating system.

6   What are the differences between a compiler and an interpreter?

7   Choose the most appropriate alternative for the following questions.

A   With 5 bits it is possible to represent
   a) 5^2 differnet symbols
   b) 2^5 different symbols
   c)   2 X 5 different symbols
   d)   5 different symbols
   e)   None of the above

B   Which statement is true
   a)   Assembly language programmes are machine independent.
   b)   Machine l nguage programmes are machine independent.
   c)   High level languages are machine independent.
   d)   High level languages are machine dependent.
   e)   All programmes are machine independent.

C   CPU fetches information from main memory by referring to the
   a)   Variable name
   b)   Variable value
   c)   Location address
   d)   Location name
   e)   None of the above

D   Computers can be classified in the following hierarchical order.
   a)   PC, Super Micro, Large, Super Computer
   b)   PC, Large, Super Micro, Super-Computer
   c)   large, Super Micro, Super Computer, PC
   d)   Super Micro, PC, Large, Super Computer
   e)   None of the above

Answer Key

Question Nos.   A - (b), B - (c), C - (c), D - (a)

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UNIT 3   PERSONAL COMPUTER AND ITS USES

Objectives

The objectives of this unit are to give you an understanding:

● of what a personal computer is and how it is used by managers

● the most common types of software used for management applications on personal computers.

Structure

3.1   Introduction

3.2   Micro-Computers

3.3   Hardware

3.4   Applications Software

3.5   Summary

3.6   Self-study Exercises

3.7   Further Readings

3.1 INTRODUCTION

Computers were first used in management and business applications in centralised data processing departments. These departments were manned by computer specialists who were the only persons allowed access to the machines. Later terminals were provided to users for certain applications. However, cost, complexity, size and the need for special environment control did not permit computer users to have computers at their work places. All this has changed with the advent of micro-computers.

3.2 MICRO-COMPUTERS

Micro-computers are computers which have their entire Central Processing Unit (CPU) on a single integrated circuit 'chip' (called a micro-processor). Today powerful micro-computers are available which cost as little as Rs. 20,000. These micro-computers can do many of the jobs earlier done by large computers which cost many times this amount. In addition, because they are small enough to sit on a desk and do not require extensive environmental control, they can be used in most reasonably dust-free environments. Field tests on machines used in projects such as the Computer Literacy Project for Secondary Schools of the Education Ministry have shown this. This ready availability for users has enabled a large number of entirely new applications to be undertaken. It has also increased user interest in computing since users can be directly in control of their data unlike the situation with centralised computing. Due to these factors and the fact that micro-computers can be used at home and schools for education and entertainment there has been a spectacular increase in their numbers since their first arrival as hobby kits in the U.S. Several million micro-computers are used in management applications around the world today. In India the projections are that by 1995 a few millions of these machines will be installed.

3.3 HARDWARE

Micro-computers are structurally similar to large computers in that they have the same basic components – CPU main memory, secondary memory and input/output devices. The most popular secondary memory devices are floppy disk drives and fixed disks.

Floppy disks store between 140 K Bytes to 1 Mega Byte = 1024 K Bytes (MB) while hard disks store 10 MB to 40 MB. The main memory is made from several chips. These may be ROM or RAM chips. ROM (Read Only Memory) chips contain instructions permanently written in the memory. The contents of these chips cannot be altered. RAM (Random Access Memory) chips provide the memory that can be read from, written into and cleared. Most micro-computers have between 16 K by es and 1 MB memory. The typical word-size of micro-computers when they were introduced in business in the late seventies was B-bits. Today, the most common word-size is 16-bits. It is virtually certain that in the next few years 32-bit micro-computers will be very common although today their numbers are somewhat limited due to cost and scarcity of software. Dotmatrix and daisy-wheel printers are popular printing devices on micro-computers.

With the proliferation of micro-computers, the concept of distributed computing has emerged. In distributed computing, a number of computers are dispersed in different parts of an organisation and inter-connected using special cables, telephone lines or other telecommunication media. This allows data and programmes to be shared and also provides for some new types of applications such as electronic mail. To support such networking special electronic devices such as modems and network inter-face cards are often fitted into micro-computers.

As with larger computers, micro-computers have operating systems to enable the user to easily interact with the machine. These operating systems are similar to those on large machines except that they are much simpler. This is because the majority of micro-computers are not multi-terminal machines - only one user has access to the machine at any time. In this situation the machine is the personal computer of the user. Personal computers are used for a variety of tasks. The most common applications are:

Word Processing
Financial Analysis
Data Base Access
Graphics
Accounting

3.4 APPLICATIONS SOFTWARE

Systems software available on micro-computers includes compilers and interpreters for popular programming languages like BASIC, COBOL and FORTRAN. However, because of their large numbers and personal use, powerful applications software which does not require significant programming knowledge has been developed to run on personal computers. The most important categories of this software, which enables a user to autonomously utilise a personal computer are:

Data Base Management Software
Spreadsheet Software
Word Processing Software
Graphic Software
Data Communication Software

Data Base Management

Software packages called Data Base Management Systems (DBMS) had been developed long before micro-computers to handle the problems of maintaining and integrating large volumes

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of data on large machines. The most important distinguishing feature of a DBMS package on personal computers is that it provides a very high level language interface which can be learned by a user who is not a computer programmer. In a few hours, it is possible to acquire enough skill to use the basic features of DBMS packages like dBASE III which is the best selling software currently in this class.

The dBASE III package has attained its current popularity mainly for the following reasons:

1. It is easy to use and is simple. Its basic features can be learned in a couple of hours.

2. It provides a very high level language interface which is command oriented. Some people consider it a fourth generation language. In lay man's terms, fourth generation language means it is superior to standard programming languages like BASIC, COBOL, FOR TRAN and PASCAL, and it simplifies and sometimes even avoids programming in a conventional sense.

3. Small business information systems can be easily implemented in a few days using this package.

4. This package can be used as a tool to prototype large applications. Prototyping is useful for saving costs in implementing large applicaitons. Parts of a large system may be implemented through dBASE III package to finalise specifications of what users want through the envisaged application and how these parts could possibly be implemented in their final form.

Like other DBMS packages, dBASE III provides features for:

1. Creating data files on a computer.

2. Maintaining these data files by way of providing functions for adding, deleting, editing and updating a given set of data items.

3. Generating reports based on the data files created through dBASE III.

4. Querying on these data files.

To develop an understanding of the features provided by dBASE III package, let us take a specific application and see how it could be implemented in dBASE III. Suppose we are operating a small business house which has 1000 customers. We are interested in maintaining a list of these customers and using this list for our day-to-day business operations. Obviously we will have to create a file which contains data about these 1000 customers. In this file there will be one record for each customer. Thus, we will have a file containing 1000 records.
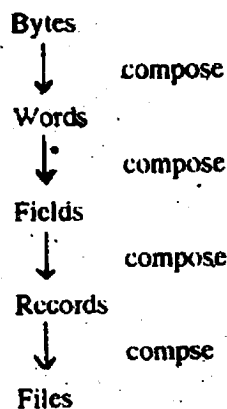
Bytes
↓ compose
Words
↓ compose
Fields
↓ compose
Records
↓ compse
Files

Fig. 3.4

1 (a) Describe the hardware of a typical personal computer system.

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Each record will have to contain details about a customer. What constitutes 'the necessary details' will depend mostly on what use we want to make of this data-base. For the sake of simplicity, let us say we will have the following information for each customer.

1	Customer Identification code	CUSTID	(G 1029)
2	Customer Name	CUSTNAME	(V.K. GANDHI)
3	Address	ADDRESS	(NARAYAN CHAMBERS, ASHRAM ROAD)
4	City	CITY	(AHMEDABAD)
5	State	STATE	(GUJARAT)
6	Pincode	PINCODE	(380009)
7	...one Number	PHONE	(77334)
8	...nount Due	AMOUNTDUE	(5249.25)
9	...redit limit	CRDLMT	(10000.00)

Each data item listed above will form a field in the record structure for the customer. When we create a customer file through dBASE III package, it will first want us to specify the record structure for the file.

For a customer file we want each record to have nine fields: one each for the items listed above. In dBASE III, it is necessary to give names to each of these nine fields so that they can be later referred to using these names. The field names which we have chosen are shown in the third column above. Apart from the name, we have to also indicate what type of data will be stored in the field and in certain cases number of characters to be reserved to hold the data for that field. We will want AMOUNTDUE and CRDLMT to hold numeric data and all other fields to hold text or character data.

Now let us have a quick look at a dialogue in dBASE III for creating and using such a file.

When we start the dBASE III programme, it prompts by dot (.). Also when it finishes executing a given command, it writes dot in the first column of next line on the screen. Interaction with dBASE III package consists mainly of issuing appropriate commands against this dot prompt.

Each dBASE III command starts with a key word (or verb) followed by certain parameters. The command for creating a file for customer data would be

..CREATE CUSTLIST

Note the keyword CREATE which is typed by the user against the dot prompt produced by dBASE III. CREATE command wants a parameter which will be used as a name for the file so created. The user can choose any name that he desires within the syntactic rules specified by the package. We shall henceforth omit such minor syntactic details of the package. We shall use the symbol ↵ to indicate enter or return key of the keyboard.

In response to CREATE command, dBASE III will provide a screen where we can enter the above nine field names alongwith their type characteristics.

Note that with this command will have only specified the structure of the record for a file which is to contain customer data. Therefore we should have some way of loading the customer records in the CUSTLIST file. For this purpose we will have to type the following command:-

..APPEND

With this command we get a screen which provides a blank customer record. As the name implies, this command will append a record to our CUSTLIST file. Thus, it can be used whenever we want to add one more customer to customer list.

In the screen provided with above command, we now type the necessary details of a customer. The names of the fields are displayed on the screen to facilitate entry of data for a customer for which we wish to create a record in CUSTLIST file. After we type in all the required details about the customer and type ↵ we get another blank record in which we can enter data about next customer and so on. When we type ↵ right at the beginning of a blank record we get back to dot prompt where we can issue a new dBASE III command.

Now suppose we want to close our dBASE III session and come next day to query this customer file. We must first exit from dBASE III. The command for this is

..QUIT

Next day when we start the dBASE iii programme, we must first indicate which file we want to use, otherwise dBASE III will not know which file we are interested in. The command for this is

..USE CUSTLIST

Now let us say we want to query on the customer data for extracting different types of information. Here is a sample list to illustrate how easy it is.

TYPE	TO GET
● LIST FOR AMOUNTDUE > 5000	Details of all customers for whom amount due is greater than 5000.
● LIST PHONE FOR CUSTID = 'G1029'	Phone number of a customer whose Identification number is 'G1029'
● LIST CUSTNAME, ADDRESS FOR CITY = 'BOMBAY'	Name and address of all customers from Bombay.
● LIST FOR AMOUNT DUE > CRDLMT	Details of all customers who have crossed their credit limit.
● LIST FOR 'SHAH' $ CUSTNAME	Customers who have a character string SHAH in their names. Note that this will list not only SHAH but also customers like SHAHNAZ.

We have seen that just with five commands we can do a lot with dBASE III package. Below are a few more commands which further illustrate the simplicity of dBASE III package.

TYPE	TO GET
● AVERAGE AMOUNTDUE	Will provide on the screen average amount that is due from the customers.
● COUNT FOR AMOUNT DUE > CRDLMT	Will show on screen a number indicating how many customers have crossed their credit limit.
● SUM AMOUNTDUE FOR CITY = 'BOMBAY'	Will give how much amount is due from customers from Bombay.

One has to learn only few additional features to see how sales and receipt transactions can be used to update amount due for each customer. The dBASE III package also has REPORT command for producing user specified reports.

With the command verbs, dBASE III also provides conventional programming features like IF - THEN - ELSE, WHILE - DO. A complete set of dBASE III programmes can be designed to implement a medium sized application in a couple of weeks.

Word Processing

Word Processing software is designed to enable the user to prepare typed documents. Thus, in contrast to data processing where the focus is generally on numerical data, in word processing the main concern is with text. In the early days of computing a disparaging remark that computer professionals employed to refer to an application system which did very little computing was to say that the system used the computer as an 'expensive typewriter'. With dropping costs and the increased productivity due to word-processing, today the micro-computer can be used as a 'cheap -typewriter'!

In order to prepare a document using a word-processing package, it has initially to be typed into the computer's memory from the keyboard. The main productivity improvement comes from the ease and rapidity with which the document can be modified. Only when the finished version is ready it is necessary to put it on paper. Where there are several drafts of a letter or report, or where extensive text from past reports is to be used the productivity gains can be very large. Typical situations where high gains are possible are: law firms, contractors, newspaper offices, bank and government offices. Studies in the U.S. have shown that the manpower required to prepare a document can be reduced from 40 to 80 per cent over using an ordinary typewriter. In addition, the document can be sent at electronic speeds over a local or long-distance network to other computers easily because it is in computer-readable form. Thus, word-processing provides a ready interface to electronic mail.

A typical word-processing package (WPP) has the following features:

Automatic wrap-around

With a typewriter, the typist has to watch for the end of the line and press the carriage return key to start a new line. With a WPP typist simply continues typing, the computer automatically starts a fresh line when a line is filled up. Only at the end of a paragraph, it is necessary to perform a carriage return.

Cursor Control

All WPP display a bright movable area the size of one character on the screen. This is called the cursor. It can be moved around the screen by pressing keys. The cursor enables the WPP user to identify an area of text where he wants to make changes.

Deletion

Characters, words, sentences, paragraphs and entire pages can be deleted by using the cursor with just one key-stroke. The text following a deletion will automatically get re-adjusted to fill the gap created by deletion.

Insertion

Just like deletion except that characters, words, sentences, etc. can be inserted anywhere in the text.

Replacement

Typed characters can over-write characters in document (this is like a combined deletion and insertion).

Movement of blocks

A block of continuous text can be moved from any point to any other point in the document.

Copying of blocks

A block of continuous text can be copied from one document to another or from one part of a document to another.

Formatting

Spacing, margins, right and left justification, page numbering can be set and changed at any time.

Besides the above standard features a number of advanced features are available on sophisticated WPPs. Some of these are:

Mail Merge

A common need in many offices is to send the same letter with changes for name and address to a number of parties. This feature enables the computer to process a file of names and addresses and merge it with a standard letter creating letters for each party.

Search and Replace

A string of characters can be replaced anywhere in the document by another string of letters. This is useful, for example, when the spelling of a person's name has to be corrected in several places.

Spelling checker

The WPP can be instructed to check spellings and point out where errors may have been made. It would also suggest what the correct spelling might be. Some WPPs also enable the user to add words to its dictionary that the user commonly uses but which are not in its dictionary. Specialised technical terms are examples of this situation.

Thesaurus

The WPPs can be requested to supply words that are similar in meaning to a particular word (synonyms) in a document.

Multiple fonts

Different styles such as italics and bold as well as different sizes and shapes of characters can be typed (provided the printer has the requisite features). Mathematical symbols, Greek letters are also available.

Electronic Spreadsheets

Electronic Spreadsheet software hailed as the single most important reason for management use of micro-computers. It is doubtful if the business world would be buying micro-computers in the volume that it does if there were no electronic spreadsheet packages. The fundamental idea of value in such packages is the concept of an 'electronic' spreadsheet. A spreadsheet is simply a sheet of paper with rows and columns in which one can enter data in the form of numbers and text. A balance sheet is a spreadsheet, a price list is a spreadsheet, in fact most managerial reports are spreadsheets. An electronic spreadsheet is like a paper spreadsheet except that:

1   It is much faster and easier to make modifications to it and to make both electronic and paper copies of it.

2   At a given time one can only see a part of the whole sheet. To see parts which are not visible, we need to scroll in those parts. It is like seeing the spread sheet through a window.

3 · In addition to allowing numbers and text it allows formulas (such as Contribution = Revenue - Variable Cost) to be entered into the work-sheet. This enables very rapid recalculation to be done under changed assumptions.

The most important capability that a spreadsheet offers is that of a straight-forward, rapid and unobtrusive sensitivity analysis. Once a spread sheet has been set up, it is very easy to answer 'what-if' questions. For example, if one has a spreadsheet reflecting all the cash-flows and other aspects of an investment, we can readily re-compute the impact of errors in our sales prediction on the return on investment.

Lotus 1-2-3 is the most popular spreadsheet software package today. The Lotus 1-2-3 spread sheet (called a worksheet) has rows entered numbered 1,2,3 upto 2048. It has 256 columns - from A, B, C, ..., Z through AA, AB etc. upto IV. Newer versions can handle more rows and columns. The width of the columns can be different and car .e adjusted to suit the application. At any time 20 rows and (typically) 8 columns are visible on the computer screen. To view other parts of the worksheet, the 'cursor' key has to be manipulated. The 'cursor' is a bright rectangle of light which is one row by one column in size. By using up, down, left and right arrow keys the cursor can be moved around on the screen. When the cursor is at the right extreme, pressing the right arrow key will 'scroll' the worksheet one column to the right, i.e., the left column(s) will disappear and a new column (the column to the immediate right of the previous right-most visible column) will appear. By repeating this action as often as required, we can move the window to the right. Similarly, by using the other arrow keys, we can move the window left, up and down as well.

To enter a number of text, we need to move the cursor to the desired row-column position (called a 'cell'). Next, the data is entered by pressing the appropriate typewriter keys. Finally, when the 'Return' key is pressed, the data will get entered in the cell and be displayed on the screen. To enter formulas a similar procedure is followed. The only difference is that instead of data, a formula is entered. A formula indicates how the value of the chosen cell depends on other cells of the worksheet. For example, if cell A5 contains the revenue figure and cell B8 contains the variable cost, and the cursor is at cell E15, entering '+A5 - B8' will ensure that cell E15 will always show the contribution value. Lotus 1-2-3 has many for more advanced features. These will be covered in greater detail in a subsequent unit.

Spreadsheet models have a simplicity which makes them natural for users. They also find use in a surprising variety of applications. Although, undoubtedly, their largest use is in financial modelling, they find frequent use in areas like marketing, production, logistics and human resources.

Business Graphics Software

While spreadsheets and database packages are very useful in doing analysis, the output of such analysis is generally tables of numbers. The human brain is much more adept at picking up patterns from pictorial representations. If it is true, as the old adage says, that a picture is worth a thousand words, it is equally true that it is worth a thousand numbers. Computer accessible data can readily be converted to graphic form on the screen as well as on paper using dot-matrix printers or plotters. With plotters it is possible to have different colours (four colours is very common).

Typical business graphics software enables data to be plotted as:

Line Charts

Bar Charts

Pie Charts

Sophisticated business graphics software provides for three dimensional display and maps.

Data Communications Software

In large organisations there is often a central computer for data processing which does routine data processing. Sometimes a manager would like to get some of this data for processing on his personal computer. To facilitate this, data-communications software has been developed which runs on the personal computers to make it look like a terminal to another computer. Using this 'terminal emulation' facility the manager can access data from his computer. Selected data can be 'downloaded' into the personal computer's memory and stored in files on disks. Subsequently, he can analyse these files using DBMS or spreadsheet software. An example of this kind of use would be a situation where a main-frame data processing computer has files on sales of products broken down by month and by region. Downloading on a personal computer would enable the manager to analyse up-to-date data on product movement in different markets.

Statistical Packages

A number of easy-to-use packages which run on micro-computers to perform standard statistical analysis are available. Typical capabilities are frequency distributions, cross-

tabulations, tests for population means and proportions, analysis of variance, contingency table tests, regression and correlation anlaysis. More advanced packages would include forecasting modules, time-series analvsis and non-parametric analysis.

Operations Research Packages

Inexpensive packages are available for standard operations research models such as linear programming, critical path analysis, resource scheduling, simulation, decision free analysis and network flows. While these packages are not as powerful as software on large machines, they are far more user-friendly and cost one-tenth to one-hundredth as much. They are powerful enough to solve problems of moderate size. For example practical linear programming models with less than 100 variables and around 50 constraints can be readily solved.

Integrated Software

Software that combines several of the capabilities of packages listed above are now available. For example, LOTUS 1-2-3 version 2 combines spreadsheet, database, graphics and statistical capabilities. Another example is FRAMEWORK which combines word-processing, spread sheet, database and graphics functions. The advantage of integrated software is that the user does not have to learn to handle a variety of disparate packages so that his learning time and effort is reduced. Another advantage is that the same data can readily be passed from one function to another. The disadvantage is that such software is expensive and makes greater demands on the computer resources.

Activity A

Prepare a brief report on functioning of the computer in your organisation, mentioning various software used. Name most commonly used language and five software packages and purpose thereof.

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3.5 SUMMARY

A personal computer is a micro-computer system that is available to a user for his exclusive use. The use of personal computers in management is growing by leaps and bounds. This is due to their low cost, small size, and the availability of very user-friendly software that runs on these machines. The major types of software that account for the popularity of personal computers are: word-processing, database management, electronic spread sheets, graphics, data communications, statistics, operations research and integrated software.

3.6 SELF-STUDY EXERCISES

1   Describe the hardware of a typical personal computer system.

2   What are the reasons for popularity of micro-computers?

3   What is meant by distributed processing?

4   Describe four important management uses of personal computers.

5   How is an electronic spread sheet superior to a paper spreadsheet?

6   Describe four functions of word-processing software that would increase the productivity of a typist?

7   Explain with examples how a data base management system provides for ad-hoc queries.

8   Illustrate with examples the common types of graphics displays provided by business graphics software packages.

9   What is meant by 'down-loading' of data?

10   What is integrated software? In what way is it advantageous in use to a manager?

3.7 FURTHER READINGS

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UNIT 4 SPREADSHEET SOFTWARE AND MANAGERIAL APPLICATIONS

Objectives

The Objectives of this unit is to give you an understanding:

● of the capability of spreadsheet software and

● its use in solving several types of managerial problems.

Structure

4.1 Introduction

4.2 Main features of LOTUS 1-2-3

4.3 Some important commands

4.4 Summary

4.5 Self-assessment Exercise

4.6 Further Readings
    Appendix

4.1 INTRODUCTION

Availability of spreadsheet along with word processing and data base management software has been responsible for the popularity of the personal computer with managers and administrators. Managers often work with tables. Sometimes they review the data in a table like in the case of a performance report which may be sent in by a subordinate or from the field. Managers also perform analysis on tables. Examples of tables being used for analysis are profit and loss statements, balance sheets, budgets, cash flows. etc.

The concept of a spreadsheet is akin to that of a table in which row and column titles and input data may be entered and some values may be derived on the basis of other values necessitating arithmetic computations. Spreadsheet is in fact a much larger table which is held on an electronic media rather than a sheet of paper. A spreadsheet is always viewed as being made up of a number of columns and rows. The intersection of a column and a row is called a cell. A cell is the basic unit with which a row or column heading may be associated, a value may be input or in which a computation may be performed. In Table I a profit and loss statement is presented for a company. To a manager the table presents the level of proposed activity during the year 1986-87, revenues that would be generated, both variable and fixed costs that would be incurred and the eventual profit that is expected to be earned. The table can be viewed as consisting of 8 columns and 20 rows and it could be said that the titles for each row are stored in column A and the corresponding values are stored in column B. It may be noted that the title of the table, each row label or a corresponding value can be associated with one specific cell. For example, the label 'Sales Qty. can be associated with cell A5 and the corresponding value of 90,000 with cell B5. Notice that a cell is addressed as a column and a row. Table I will be referenced many times in the later text. It may be useful to create an exact copy of this table in a separate sheet.

The profit and loss statement in Table I is a typical example of a table with which managers would work. In projecting the profitability for the next year a manager would like to work with various assumptions regarding production level, prices and unit costs. He would, in fact, like to construct a scenario in which his expected profit is as much as possible. For this purpose he may wish to determine the consequent impact on profits if the production was raised to full capacity. He may like to ask similar questions regarding price, unit cost, advertising expenditures - items which are somewhat under his control. Spreadsheet provides an easy mechanism to do such analysis which is typically known as 'what if' analysis.

TABLE 1

	A	B	C	D	E
1		ALPHA CO.			
2		PROFIT AND LOSS STATEMENT 90-91			
3					
4	REVENUE			PARAMETERS	
5	Sales Qty.	90000		CAPACITY	150000.00
6	Unit Price	4		CAP UTIL.	0.60
7	Sales value	360000		UNIT MAT. COST	1.00
8	VAR. COST			UNIT. LAB. COST	1.10
9	Materials	90000		UNIT SHIP COST	0.04
10	Labour	99000		RATE OF COMM.	.05
11	Shipping	3600			
12	Commission	18000			
13	FIXED COST				
14	Advertising	40000			
15	Fact. Overhead	88000			
16	Adm. Exp.	22000			
17					
18	CONTRIBUTION	149400			
19	TOTAL FIXED COST	150000			
20	PROFIT/LOSS	600			

Note: It may be advisable to make a copy of this table in a separate sheet for further reference.

Spreadsheet is a software which would allow you to create tables as in Figure 1 and to manipulate numbers in these tables to perform 'what if' analysis. Several spreadsheet packages are available in the market. Some of these are VISICALC, SUPERCALC, MULTIPLAN, LOTUS 1-2-3 etc. In this unit when we discuss the mechanics of creating and working with a spreadsheet, we would do so by discussing some elements of LOTUS 1-2-3. This package is available on IBM/PC compatible computers having at least 256 KB of memory. More than a million copies of this package have been sold. LOTUS 1-2-3 allows a user to work with table:

which may be as large as 2,048 rows and 256 columns. Columns are numbered from A to Z, AA to AZ and so on up to IV. The rows are numbered from 1 to 2,048. When the LOTUS 1-2-3 programme is executed on a PC the worksheet screen that appears on the monitor is shown in Figure 1. Most spreadsheet packages have similar format. Notice that there is a thick border (on the monitor it will be in reverse video) within which the column and row numbers are indicated. The area to the bottom of the border is called the worksheet area in which one or many tables may be created and manipulated. Above the border there are three lines which are called the control panel. We will first understand how to operate in the worksheet area.

Although the total worksheet area is large (256 columns and 2048 rows) the area that can be seen at any time is small. One can see 20 rows and 8 to 9 columns. Of course, the number of columns that can be seen depends on the width of the column which can be defined by a user. Thus, if the width of the column is 1 character 72 columns can be seen and if it is 72 characters only one column can be seen. The first thing is therefore to learn to see the other parts of the worksheet which are hidden at any point of time. The screen in Figure I shows the cursor which is a lighted area covering exactly one cell. Currently, it is shown covering cell B2. This cursor can be moved about by pressing certain keys in the keyboard. It is extremely important to be familiar with the key board which is shown in Figure II (See in Appendix). The keys marked with arrows when depressed will result in the movement of the cursor one cell at a time. Thus, if the right hand arrow key is depressed five times the cursor will move to cell B2. Now, if the cursor is moved once more, rather than going over the board, it will remain in the same position However, the next column J will appear on the screen and the first column A will disappear. It is as if a window, through which the worksheet was being viewed, has been shifted one column to the right. Similar shifts of this window can be done sideways or upwards and downwards to view any part of the worksheet. Obviously, tapping the key several times to move the worksheet through large areas can be laborious. There are page up and page down keys to move 20 rows or many columns (72 characters) at a time. There is also a key home which can bring the cursor to A1 from anywhere in the worksheet.

Three types of information can be stored in any cell in a worksheet. Labels (textual information) which is normally used to indicate table titles or row and column headings. Numbers which may be input to indicate values of different items in a table and formulas which will relate the value of a cell to the data stored in other cells.

Let us understand lebels, number and formula with reference to the Table I. Table heading, company name, 'Revenue', 'Unit Price', names of various cost elements, etc. are labels. You would notice that corresponding values shown in the table are either given or derived from other values in the table. For example, the value of unit sales is given as well as the value of unit price. However, the value in cell B7 showing the sales value is derived from Sales Qty and unit price. Normally, a person may use a calculator to perform such arithmetic. However, each time the prices of the units are changed the arithmetic would have to be performed again. In a spread sheet, the user would be able to write a formula for such derived values. For example, in cell B7 the formula would be B6 * B5 expressing revenue as a quantity obtained after multiplying the value in B5 with the values in B6. When cells addressed B5 and B6 are used in a formula it is immaterial as to what is the actual number in these cells. Whatever is the number in these cells at any given time will be used to derive the value of revenue. Therefore, if the value in B5 is changed from 90,000 to 1,50,000 the sales value in cell B7 will automatically become 1,60,000.

To put labels, numbers or formula into a cell the cursor must first be positioned in the specific cell. Remember that the cursor can be posistioned by manipulating the arrow keys. After positioning the cursor, textual matter or numbers may be typed in from the key board. The use of a computer key board is just like the typewriter key board. However, when a formula is typed in, to distinguish it from a number or text it must begin by a (+) sign. When a label, a number, or a formula is typed in, it will appear on the third line of the control panel. After the return key is pressed the matter will get stored in the cell (will appear in the cell and will disappear from the third line of the control panel). The first line of control panel always indicates the cell in which the cursor is positioned and its contents. If the contents are a formula, the formula expression would be shown. However, in the cell if the contents are a formula then their computer value is shown.

Let us see how the profit and loss table can be created. First, the cursor will be moved to cell C1 and 'ALPHA CO' will be keyed in followed by a 'return' and similarly PROFIT AND LOSS STATEMENT 91-92 will be stored in cell B2. Then the cursor will be moved from cells A4 to A20 and in each cell the respective row label will the typed followed by a return. The amount of information stored in a cell can be large (upto 240 characters) and will be displayed on the screen as long as the column width is adequate or the cells in the next colum is are blank.

Similarly labels will be stored in D4 to D10 for various parameters whose values will be stored in corresponding cells from E4 to E10

The input numbers which are 'given' and which do not vary in th short-run will be typed in next. These are capacity, various elements of fixed costs and unit costs. Each number will be keyed into the cell corresponding with the label. For example, the number 1,60,000 denoting capacity will be typed in cell E5. The screen will then appear as in Figure I.

Now the formulas can be typed in to compute quantities which depend on the value of other cells. Thus the following formulas will be typed in:

B5   : + E5 * E6 Sale Qty. = Capacity X expected cap utilisation
B7   : + B5 * B6 Sales Value = Sale Qty. * Unit price
B9   : + E7 * B5 Total material cost = Unit mat cost * Sales Qty.
B10   : + E8 * B5 Total labour cost = Unit labour cost * Sales Qty.
B11   : + E9 * B5 Shipping Cost = Unit shipping cost * Sales Qty.
B12   : + E10 * B7 Total Sales Commission = Rate of Commission X Sales value
B18   : + B7 - B9 - B10 - B11 - B12 Contribution = Revenue - Variable Cost
B19   : + B14 + B15 + B16 Total Fixed Cost
B20   : + B18 - B19 Profit = Contribution – Fixed Costs

Once the above formulas are typed in, the cells will indicate the computed value of the formulas. Now the worksheet is ready to be used for what-if analysis.

For example, the Sales Manager of Alpha believes that a 15% reduction in price will fill the plant to capacity. Is this move desirable? This can be determined by changing the contents of cell E6 to 1 (reflecting full capacity utilisation) and the contents of B6 to 4*.85 (reflecting 15% reduction in price). As soon as contents of a cell are changed, the value of all cells which depend on the value of the cell in question will be automatically recalculated. (Unless the user wishes not to recalculate the values). Therefore, on changing E6 and B6 to the new values B5, B7, B9, B10, B11, B12, B18, B20 will be immediately recalculated. In small worksheets the

recalculation is almost instantaneous. The new profit/loss can be read off from B20. This is the fantastic power of a spreadsheet.

Another scenario which the MD of the company would like to evaluate is to increase price by 25%, increase advertising by 12,000 and boost commission to 10% of sales value. He thinks Sale Qty. will increase by 50%. Such a scenario can be evaluated by plugging in the new numbers in appropriate cells and noting the recalculated profit in B20.

Figure I

Lotus Screen for Alpha Co.

B2: PROFIT AND LOSS STATEMENT 1990-91

	A	B	C	D	E	F
1			ALPHA CO.			
2			PROFIT AND LOSS STATEMENT 1990-91			
3						
4	REVENUE			PARAMETERS		
5	Sales Qty.		XXXXXXXX	CAPACITY	150000.00	
6	Unit Price		4	CAP UTIL.	0.60	
7	Sales value		XXXXXXXX	UNIT. MAT. COST	1.00	
8	VAR. COST			UNIT. LAB. COST	1.10	
9	Materials		XXXXXXXX	UNIT. SHIP COST	0.04	
10	Labour		XXXXXXXX	RATE OF COMM.	0.05	
11	Shipping		XXXXXXXX			
12	Commission		XXXXXXXX			
13	FIXED COST					
14	Advertising		40000			
15	Fact. Overhead		88000			
16	Adm. Exp.		22000			
17						
18	CONTRIBUTION	XXXXXXXX				
19	TOTAL FIXED COST	XXXXXXXX				
20	PROFIT/LOSS	XXXXXXXX				

XXXXXXXX Cells where formulas have to be put in

4.2 MAIN FEATURES OF LOTUS 1-2-3

Ability to build fairly complex models quickly

The model discussed above was a simple one. It modelled the profits as a function of various parameters like price, unit costs, capacity utilisation. Such a worksheet could be put up in 30-45 mts whereas manual calculations or programming the problem in a conventional language like BASIC could take much longer.

The model built earlier could be further refined. Currently the worksheet does not relate sales to price, commission or advertising expenditure. The relationship must exist (as when the MD expects 50% increase in proposition 2). However, it has not been modelled explicitly.

Such a relationship could be modelled in LOTUS 1-2-3 by expressing sales qty. in cell B5 as a function of price change, advertising expenditure and commission through formulas.

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Alternatively a 3-way table could represent the sales quantity as a function of the three parameters. We have not discussed how such a table could be built and used but the appropriate commands will be described in Appendix.

Functions in LOTUS

There are certain computations that need to be done frequently by managers. LOTUS 1-2-3 has therefore predefined formulas for such computations stored as functions. These functions can be used as formulas or within a formula. For example, the total of a number of cells could be computed in any cell by using a function @ SUM (cell range and/or cell addresses). Specifically for the worksheet discussed earlier, total fixed costs in B19 could have been expressed as @SUM (B14.. B16). A number of such functions for mathematical and statistical computations, trignometric functions, financial analysis like net present value that are available are listed in Appendix.

Mention must be made of functions that provide logical capability of choosing one of many options. If the tax incidence had to be computed for Alpha company in cell B21, given a tax rate stored in E11, then the formulae in B21 could have been: @ IF (B. 20> 0, B20*E11, O). Such a function first tests a condition - in the present case the condition is: is the profit greater than O, i.e. is it a profit or a loss. If the condition is true then the cell (where the function is used) will take the value indicated immediately after the condition. In this case B20*E11 which is the incidence of tax. If the condition is false (Alpha has made a loss) then the cell will take the value indicated by the third expression in the bracket i.e., zero in this case. LOTUS has many such functions which are also listed in the Appendix.

Sensitivity Analysis

Ability to perform what-if analysis was illustrated in the earlier example. LOTUS 1-2-3 can also perform such analysis in an automatic way. For example, a separate table may be created for capacity utilisation varying from .4 to 1.0 in steps of .1 in cells E 14 to E20. It would then be possible to instruct the LOTUS system through a command called DATA TABLE (listed in appendix) to substitute each of these values one by one in cell E6, and to read the corresponding recalculated profit from B20 and to store the value in cells F14 to F20 automatically. Notice the convenience of doing the analysis automatically vis-a-vis doing it by changing cap utilisation in cell E6 manually and then recording the profit figure in a sheet separately or keying it manually into cells F14 to F20.

LOTUS 1-2-3 Commands

We have seen in the earlier parts of this chapter as to how a table can be created and manipulated using a spreadsheet package. A spreadsheet package also offers the user the flexibility of re-arranging the matter in a worksheet. Thus, columns and rows may be shifted (without having to rewrite formulas), certain cells may be erased, the screen could be split up into two vertical or horizontal windows, the format of numbers could be changed and the width of a column could be adjusted. All these and more operations can be performed by executing specific commands from a command menu. A user can also print the contents of a worksheet, create a file on a floppy for subsequent access and data can be read into a worksheet from other types of files.

The command menu like a restaurant menu offers various choices of which one may be executed (unlike in a restaurant) at a time. The command menu for LOTUS 1-2-3 is shown in Appendix. A command menu may be viewed on the screen by typing a slash. Once the command menu is up on the screen in the second and third lines of the control panel, the worksheet enters a menu mode. You cannot then manipulate the cursor in the worksheet area and therefore entering or changing data in the worksheet is temporarily suspended. To execute a command the first letter of the command may be typed or the cursor on the command menu can be pointed to the specific command (by moving right hand and left hand arrow keys). After pointing to the specific command, the return key must e depressed to execute the command. On exec ion the LOTUS systems will ask for other relevant inputs which need to be supplied from the key board. It is best to understand the execution of these commands on a PC by actually working with the software. However, in Appendix a new line explanation is given for each command to explain the facility that the command offers.

4.3 SOME IMPORTANT COMMANDS

We have chosen to discuss DATA and GRAPH commands in a little detail because these commands enable a LOTUS 1-2-3 user to do more than the spreadsheet analysis discussed earlier. The COPY command is discussed in detail because it greatly facilitates the building up of a worksheet in many situations

Copy

This command allows the user to copy the contents of a group of cells from one area of the worksheet into another area. For example, one may wish to create copies of labels and formulas in column A & B in the alpha worksheet or in other columns in E, F, G & H etc. where the profit and loss under different assumptions could be shown. First we will have to understand the mechanism of addressing group of cells.

In LOTUS 1-2-3 a group of cells is called a RANGE and is addressed by the left hand top corner cell and the right hand bottom corner cell. For example, the cells containing labels in column A of Figure I will be referred to as A4..A20. The figures below indicate the address for a column of cells, a row of cells, box of cells or a single cell.

A 11..A 13   C 11..C 11   C 13..E 13   P 11..H 13
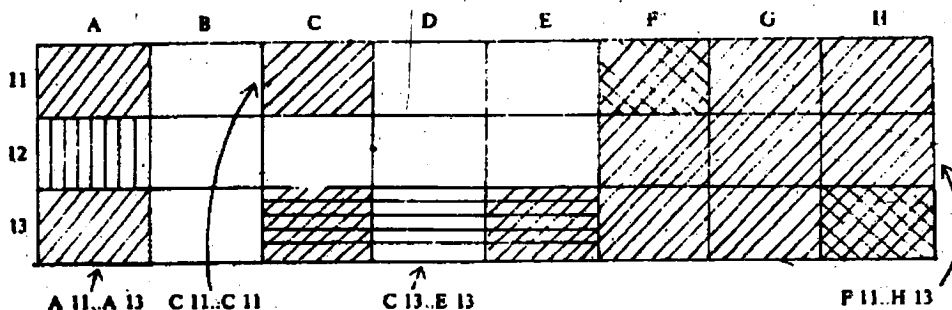
When a COPY command is executed, the user must specify a FROM RANGE (which cells are to be copied) and a TO RANGE (to be copied into which cells). When the cells being copied contain labels and numbers an exact replica is created when the copy is made. However, in copying a formula, the contents of a cell may get altered. A formula like + B1 + C3 in cell A2 would be interpreted as adding in cell A2 the contents of a cell which is one row above and one column to the right to a cell which is one row below and 2 columns to the right. Thus the formula interprets the cell addresses in a relative manner. When the contents of cell A2 are copied into another cell say B3, the relative nature of the formula will be preserved by appropriately redefining the formula. Therefore, the formula in B3 will read C2 + D4.
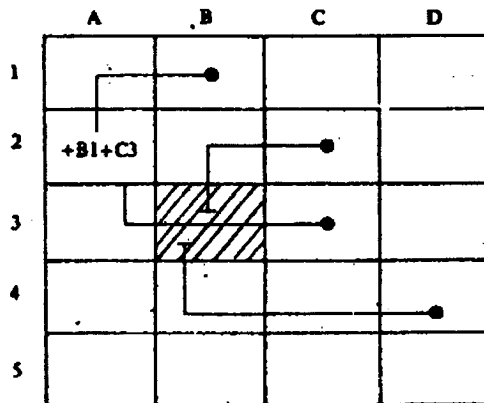
However, if the formulas in A2 were stored as A2 + C3 (each row and column address prefaced by a $) then such an address is called an 'absolute address'. When such formulas are copied, their form remains intact and the resulting formulas in B3 will continue to be A2 + C3.

In designing worksheets many times identical computation/operations need to be carried out on several cells. For example profit computations for one year in a column may be repeated in other columns for future years. COPY command applied to relative, absolute or mixed addresses (A$2, $A4) can be very useful.

Data Base Capacity

A LOTUS worksheet can also be used to create small data bases consisting of upto 1000 records and upto 30-40 (theoretically 256) fields in each record. The fields are defined in columns with the first row defining the names of each field. The data for each record is stored in successive rows. Such a data base can be defined in any area of the worksheet and can use all the features of a spreadsheet software.

One of the DATA commands will then allow a user to QUERY the data base i.e. select records which satisfy a criteria defined by the user. For example, if an employee data base was created, the user could select employees satisfying the following types of conditions.

Salary	> 2000
Place	= Ahmedabad
Salary	> 2000 AND Age > 40
GRADE	= 3 OR GRADE = 5

The user would have to specify such criterion in a specific format in a designated RANGE called CRITERION and will have to indicate to the system an INPUT RANGE specifying the location of the cells containing the data base. Through the use of data base functions in a cell, statistics like totals, variance, etc. could be computed for select records automatically.

A command called SORT also allows a user to rearrange the data base in ascending/descending order of value of any field.

Graphing Capability

The GRAPH command allows a user to draw various types of graphs on the basis of data stored in a worksheet. The user has the option of drawing a BAR CHART or a STACKED BAR for upto 6 variables at a time. For example the bar chart below plots sales, variable cost and profits for two years.
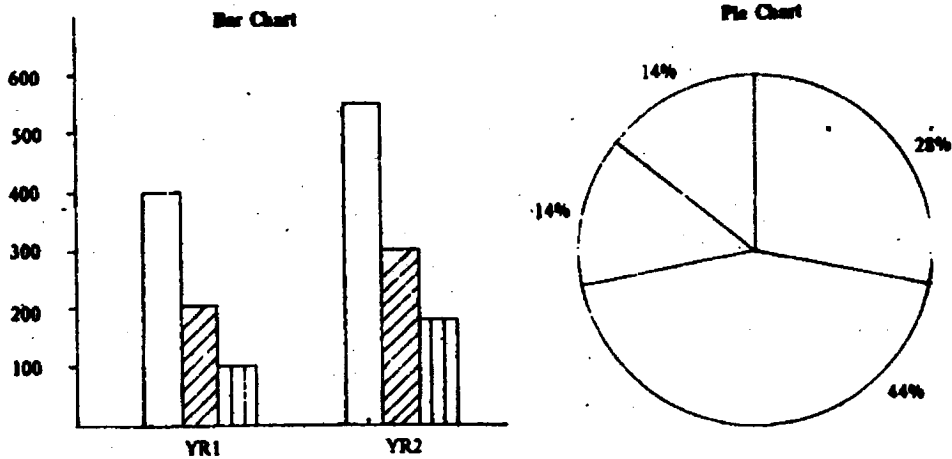
A pie chart can be drawn on any set of data which represents the various elements of a whole. For example, the pie chart above represents cost element of the total cost in a year. The GRAPH command also allows the user to draw a graph between two variables, each represented on one of the axis. In such graphs a point will represent a pair of values for the first and the second variables.

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4.4 SUMMARY

This unit attempted to expose you to the capabilities of a spreadsheet software and in particular to LOTUS 1-2-3. The mechanics of using LOTUS were not discussed. These must be learned on a PC by actual use of the software.

The steps involved in using a spreadsheet package for solving problems typically encountered by man: ers were discussed. The ease with which models can be built was illustrated. Broad features of LOTUS 1-2-3 which combines spreadsheet, graphics and data base were described. Finally some advantages of using spreadsheet packages were documented.

The LOTUS is popular because of the usability of spreadsheet analysis in various managerial problems, and the fact that it can be learnt with little effort. There are some features of LOTUS that have not been mentioned so far. It has an extensive HELP facility which provides explanation of various commands and functions. HELP can be used by pressing the function key (keys to the left of the key board) F1. There are 9 other function keys. A one line description is given for all the function keys in the Appendix.

LOTUS also offers limited programming capability through MACROS. These might be classed as advanced concepts and allow a user to repeat several LOT 3 commands through one key stroke. Macros also allow a user to repeat a sequence of instructions and create special menus which can be displayed on the control panel. Major use of MACROS is by professionals who design easy to use worksheet templates for particular types of analysis which can be used by simply making menu choices even by a manager unfamiliar with LOTUS.

LOTUS 1-2-3 was designed for performing financial analysis like budgeting, ratio analysis, cash flow analysis, investment analysis, and leasing; loans and amortisation computation.

However, managers soon discovered its use in a variety of other applications. Today, LOTUS 1-2-3 is extensively used by marketing managers for analysis of markets and sales, demand forecasting, costing and pricing, retail analysis, allocation of promotional e. ,enditure. It has been reported that 20% of the LOTUS sales are to engineers. In fact all types of professionals are using it.

4.5 SELF-ASSESSMENT EXERCISES

1   State and explain what a command is List some LOTUS 1-2-3 Commands

2   Describe different functions and applications of LOTUS 1-2-3.

3   Describe various capabilities of a spreadsheet software.

4.6 FURTHER READINGS

Michael, Laric and Ronald, 1984 *LOTUS - 1-2-3 Manual*, Lotus Corporation.

LOTUS 1-2-3 for Marketing and Sales, Prentice-Hall: Engelwood-Cliffs.

Douglas, Ford Cobb and Leith, Anderson. 1984. *1-2-3 for Business*, One Corporation.

Geofferey Leblong and Douglas, *Ford Cobb. 1985 Using 1-2-3*, Que Corporation.

Jorgensen, 1986. *Master 1-2-3*, BPP Publications: New Delhi.

Gilbert and Williams, 1985. *ABC of 1-2-3*, BPP Publications: New Delhi.

Brooks, 1987, *101 Spread Sheet Exercises*, Mc-Graw Hill: New York.

APPENDIX

LOTUS 1-2-3 Command Trees with brief description

WORKSHEET

Global	:	Controls over-all settings for all the cells in a worksheet
Format	:	Set the display appearance of numbers (various formats: Fixed, Scientific, Per cent, Text, etc.)
Lebel-Prefix	:	Control label alignment within a cell
		Left : Right: Centre
Column-Width	:	Sets width of all columns. May be 1-72 characters wide
Recalculation	:	Controls recalculation options
		Natural, Column-wise, Row-wise, Automatic, Manual, Iteration
Protection	:	Contents of a protected cell cannot be modified. Controls access to protected cells through Enable, Disable
Insert	:	Creates a blank column/row
Column	:	Shifts the contents of all columns to the right of a specified column by one column. The formulas in shifted columns are readjusted automatically.
Row	:	Shifts the contents of all rows below a specified row down by one row. The formulas in shifted rows are adjusted automatically.
Column	:	Erases the contents of a specified column and shifts leftwards. The contents of all columns to the right by one column
Row	:	Erases the content of a specified row moves upwards the contents of all rows below by one row
Column-Width	:	Controls width of a specified column
Set	:	Set new width
Reset	:	Returns to global width
Erase	:	Erase entire worksheet
Window	:	Split display screen in two parts - Horizontal and Vertical. In each part the entire work sheet can be scrolled in a synchronised or unsynchronised mode
Status	:	Display global settings

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RANGE

Format
Label-Prefix
Erase   : Similar to options under worksheet but operate on a specific part of
Protext   the worksheet.
Unprotect

Name   : A range can be given a name (CREATE) through which it can be
                referenced subsequently. Names can be deleted (DELETE) and
                labels can be used to name adjacent cells (LABEL).

COPY   Copy range contents to new location. Previous contents of the new
                location are erased

MOVE   : Move range contents to new location. Previous contents of the new
                locations are erased

FILE

Retrieve   : retrieve worksheet from disk file

Save   : store worksheet on disk file

PRINT   : For printing worksheet

GRAPH   : Graphics commands

Type   : select graph type

Line   : graph upto a maximum of 6 data sets (A-F ranges) as lines and/or
                symbols

Bar   : graph upto a maximum of 6 data sets (A-F ranges) as clustered bars

XY   : plots pairs values of 2 data sets as points on a XY graph on which both
                axes are scaled.

Stacked-Bar   : graph upto a maximum of 6 data sets (A-F ranges) as stacked bars

Pie   : Graph A single range as pie chart

X A B C D E F : X range defines the Tables that would be used on the X axis of Line,
                bar, stacked bar and on the periphery of a pie chart. A-F ranges define
                the data sets that would be used to plot the graphs.

Reset   : return settings to default values

Graph   : clear all graph settings

X A B C D E F : remove range from current graph

Quit   : return to main-Graph menu

View   : display current graph on screen

Save   : save current graph as a picture in disk file

DATA   : Data base command

Fill   : fill range with a series of numbers

Table   : tabulate formula values

1	:	Automatically vary contents of one input cell and tabulate one or more formulas. Contents of input cell to be taken from a column of numbers stored in a specified area of the worksheet, prior to executing the command.
2		Automatically vary contents of two input cells and tabulate one formula. Contents to be picked up from a column and row of numbers already created in some area of the worksheet.
Sort	:	Rearrange records (rows) in a data base in a specified range on the value of one field (column).
Data-Range	:	set range to short
Primary-Key	:	set first column to sort on
Secondary-Key	:	set second column to sort on
Reset	:	cancel all sort settings
G	:	perform the sort
Quit	:	return to/Data menu
Query	:	perform operations on a database
Input	:	specify the database range
Criterion	:	specify the range where selection criterion will be specified
Output	:	specify the range where selected records will be output
Find	:	highlight records matching criteria
Extract	:	copy all records matching criteria to output range
Unique	:	extract, but delete duplicates
Delete	:	delete all records matching criteria
Reset	:	cancel input, criterion and output ranges
Quit	:	return to Ready Mode
Distribution	:	calculate frequency distribution
QUIT	:	leave 1-2-3

F1-F10 Operations

Function Key	Name	Operation
F1	Help	Displays the Help Screen
F2	Edit	Switches into or out of the Edit Mode
F3	Name	In the Point Mode, displays menu of range names
F4	Abs	In the Point Mode, designates cell addresses as absolute
F5	GoTo	Used to move the cell pointer to a designated cell

F6	Window	Used to move the cell pointer to the other side of the split screen
F7	Query	Repeats the Data Query operation last used
F8	Table	Repeats the Data Table Operation last used
F9	Calc	Recalculates the worksheet
F10	Graph	Recreates the last graph drawn

1-2-3 Function

Function	Configuration	Description
Mathematical		
@ABS	@ABS (a)	absolute value
@ACOS	@ACOS(a)	arc cosine
@ASIN	@ASIN (a)	arc sine
@ATAN	@ATAN (a)	2-quadrant arctangent
@ATAN 2	@ATAN (a,b)	4-quadrant arctangent
@COS	@COS (a)	cosine
@EXP	@EXP (a)	exponential
@INT	@INT (a)	integer
@LN	@LN (a)	natural log
@LOG	@LOG (a)	absolute value
@MOD	@MOD (a,b)	modulus of a/b
@PI	@PI	(pi)
@RAND	@RAND	random number (0 to 1)
@ROUND	@ROUND (a,b)	round a to b decimal places
@SIN	@SIN (a)	sine
@SORT	@SORT (a)	square root
@TAN	@TAN (A)	tangent
Statistical		
@AVG	@AVG (list)	average of values in a list
@COUNT	@COUNT (list)	counts items in a list
@MAX	@MAX (list)	maximum value in a list
@MIN	@MIN (list)	minimum value in a list
@STD	@STD (list)	standard deviation of a population
@SUM	@SUM (list)	sum of values in a list
@VAR	@VAR (list)	variance of a population

Logical

@IF	@IF (expression true clause, false clause)	if expression = true, true clause if expression =/= true, false clause
@ISERR	@ISERR (a)	1, if a = ERR 0, if a = ERR
@ISNA	@ISNA (a)	1, if a NA 0, if a =/= NA
@FALSE	@FALSE	0
@TRUE	@TRUE	1

Financial

@FV	@FV (payment, interest, periods)	future value
@IRR	@IRR (guess, range)	internal rate of return
@NPV	@NPV (interest rate, range)	present value of a series of unequal payments
@PV	@PV (periodic payment. periodic interest rate, no. of periods)	present value
@PMT	@PMT (principal, periodic interest rate, no. of periods)	periodic payment amount

Database

(Here 'a' is the number of columns to the right of left-most)

@DAVG	@DAVG (input range, a, criterion range)	averages of values meeting criteria
@DCOUNT	@DCOUNT range, a, criterion range)	counts records that meet criteria
@DMIN	@DMIN (input range, a, criterion range)	minimum value that meets criteria
@DSTD	@DSTD (input range, a, criterion range)	standard deviation of values meeting criteria

| @DSUM | @DSUM (input range, a, criterion range) | sum of values meeting criteria |
| @DVAR | @DVAR (input range, a criterion range) | variance of values meeting criteria |

Date

@DATE	@DATE (year, month, day)	returns a date serial no.
@DAY	@DAY (a)	day number of a date serial number
@MONTH	@MONTH (a)	month number of a date serial number
@TODAY	@TODAY	returns the last date input when 1-2-3 was loaded
@YEAR	@YEAR (a)	year number of a date serial number

Special

@CHOOSE	@CHOOSE (tes response, response, response,...)	selects an argument
@ERR	@ERR	ERR
@HLOOKUP	@HLOOKUP (test, table, a)	horizontal look-up
@NA	@NA	NA
@VLOOKUP	@VLOOKUP (test, table, a)	vertical look up

Figure 2: Key Board
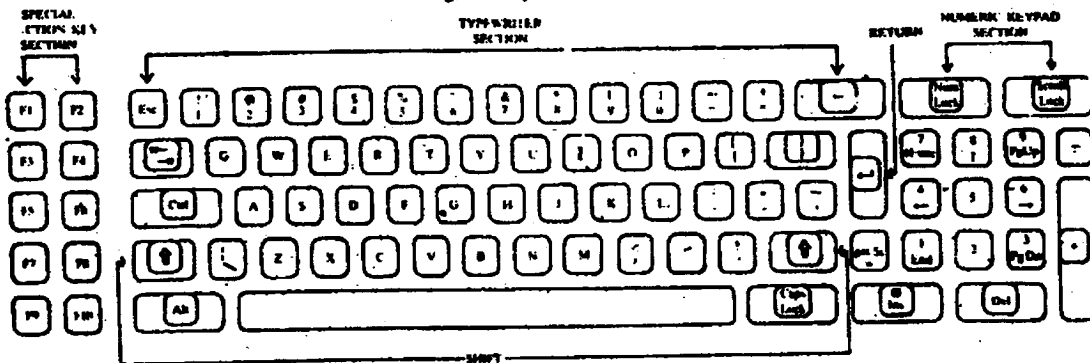
BLOCK 1 BASIC MATHEMATICS FOR MANAGEMENT

The block comprising four units discusses comprehensively the basic mathemtics, which is of wide application in day-to-day life of a manager.

The first unit deals systematically with various aspects of quantitative techniques and their applications in managerial decision-making. This unit also acquaints you with some of very frequently used models of statistical analysis in operations research.

The second unit gives you an insight into different aspects of the types of functional relationships among business variables, and their applicability in various fields of management.

Subsequently the third unit explains systematically in detail various uses of calculus and other closely related concepts for mnagerial applications.

Main thrust of the last unit is to give you the basic concepts, theoretical operation and various applications of matrix algebra in quantitative analysis of managerial decisions.

UNIT 5   COMPUTER AND MANAGEMENT FUNCTIONS

Objectives

After reading this unit, you should be able to:

- understand the role of computer in Management Decision-making
- appreciate the need for proper handling of the information and an efficient Management Information System at corporate level.

Structure

5.1 INTRODUCTION

The common experience in the Indian scene has been a plethora of transaction-processing systems which have been abiding for long. Left to themselves, computer professionals have usually been good at planning, designing developing and implementing the transaction-processing systems, due to their inherent advantages of recurring qualitative data and decisive logic base. On the other hand, MIS at a corporate level always needs involvement of the user-manager, in an intensive way and this has shown a tardy growth.

We enumerate below a few selective applications in some of the decision-making areas.

5.2 FINANCIAL DECISION-MAKING

At corporate level MIS would still need the data-base comprising the transaction-processing inputs, such as cash transactions, receipts, issues, returns, rejections, interests, depreciation, etc. The other inputs are in the nature of the various accounting rules and procedures, apart from the scales of payment.

Based on the above, the financial management decisions are made with monthly and annual final accounts, profit and loss accounts, balance-sheet etc. In addition, cash accounts are needed by management, apart from the cost accounting, pay-roll accounting, suppliers ledger and preparation of capital and operations budget.

To build up a corporate-level MIS, one can look at such selective data as bills payable and bills receivable, and segregate them commodity-wise, establishment-wise, region-wise, instru-

ment-wise and age-wise. This immediately gives a management decision-making capability to examine and take remedial action on the differences and deviations from the set pattern. The analysed data for financial decision-making can have various management ratios and management trends leading on to managerial forecasts. Linked data can be of the form of inter-related items between finance and inventory, between finance and marketing, between finance and production costing, and between finance and personnel. Integrated data can take the form of obtaining a picture for total credit, total sales turn over, total profit and so on.

The corporate areas to be helped would be cash planning, credit planning, profit planning, and facility planning. For instance, cash inflow and outflow are of great interest for most organisations and much monumental bankruptcy had taken place in such organisations as Rolls Royce in the early 70s due to the faulty cash-flow adjustments. Similarly, the credit planning takes care of voluntary and involuntary credit, in establishment where voluntary credit is often deliberately introduced to push new products, to lift accumulated stock or to provide relief to bulk customers. In all such areas, decision-making is facilitated by an appropriate MIS, as has been experienced in many Indian production organisations.

In a service organisation, investment planning and budget planning are additional features. Interestingly, budget planning can be a common feature in both production and service organisations. In particular, the banking organisations have shown a tremendous scope for corporate MIS in terms of trends, analysis and forecasts arising out of various reconciliation processes such as inter-branch, inter-bank, or even for such instruments as bank drafts and travellers cheques.

In the domain of public administration, commercial tax data-base has been built-up in some of the Indian States for various categories of taxes on commodity-wise, establishment-wise, region-wise and year-wise bases. Such a data-base has given rise to a capability to concentrate upon tax evasion cases selectively, to strengthen the inspection machinery for tax non-realisation cases, to keep track of recovery of diverse instalments in court-injunction cases and generally to streamline pursuit of the outstandings. In the States of Karnataka and Maharashtra most of these steps undertaken today are based on computerised MIS.

Activity A
Record your perceptions about the role of Managment Information System in Financial Decision-making in your organisation.

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5.3 PERSONNEL DECISION-MAKING

Personnel pay-rolls have been an old hat in transaction-processing systems. In a number of organisations, pay-rolls have been extended to cover the entire gamut of employee service,

namely, income-tax assessment and recovery, provident fund accumulation and withdrawal, compulsory deposits (when they existed) and statutory reports and returns. A comprehensive data-base for personnel decision-making would require not merely such financial data but also other categories of pre-recruitment and post-recruitment personnel data.

Examples of comprehensive personnel data would include prior qualifications, experience, categories and grades of posting, places of transfer, experience gained, new qualifications acquired, training undertaken, disciplinary actions, merit rewards and performance appraisals, etc. Such a data-base can be used for retrieval of selective data to assess grade-wise, year-wise and region-wise personnel inflow and out flow, for deciding upon recruitment planning as well as promotion planning. A similar approach can be undertaken to match availability of persons experience-wise, location-wise and duration-wise with the demand of such persons in new locations with appropriate grades and experience for purposes of personnel plan. Career development planning can also be done while looking at the grade-wise, experience-wise and qualification-wise profile and decide on fresh areas of training and education.

Finally, retirement planning can be done by looking at the selective aggregation of data on personnel wastage, so that recruitment can be undertaken and the bulk of retirement benefits can be released rightaway, pending the settlement of accounts.

Personnel decision-making based on corporate MIS has become quite common in a number of large industrial organisations in the country. In addition, states like Andhra Pradesh and Madhya Pradesh have often done personnel planning for doctors and teachers respectively using comprehensive data-base approach. Bhilai Steel Plant has planned total human resource management with creation of complete data-base including history and skills of personnel; and manpower planning and administration, including establishment functions; training needs as identified in the appraisal reports and so on.

Activity B

Make a list of the pre-recruitment and post-recruitment personnel data required by your organisation for personnel decision-making.

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5.4 MARKETING DECISION-MAKING

Sales invoicing and sales accounting have been the early transaction-processing systems in most organisations. The inputs have been the production, inspection and despatch of documents on goods produced and despatched apart from the price schedules and some occasional returns. Such data can be built into a comprehensive data-base which can help eventually the market planning and the publicity (advertisement) planning on one hand and linkages with order-processing on the other.

Both market planning and publicity planning depend on the creation of a number of profiles with full particulars such as customer profile, product profile and user industry profile. The seasonality of orders, the trends in market fluctuations, the philosophy of industrial indents and the ebb and flow of relevant markets can be assessed and taken care of in such a planning process. On the other hand, linkages with order-processing gives a vital control on the quantity to be produced or suspended to meet live and dead orders respectively. Such a dynamic interfacing can help to eliminate a lot of infructuous order execution and finished goods inventory creation, as has been experienced in the Tata Steel.

Activity C

Prepare a brief report on the market planning and publicity planning of your organisation, and the role computers and MIS can play in that.

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5.5 PRODUCTION DECISION-MAKING

The basic inuts are the salient production data culled periodically from all the production shops as and when the main events occur. The corporate MIS would involve: performance review on a periodic basis (daily, monthly and annually), monitoring of in-process inventory, balancing of daily finished and semi-finished stocks, yields and other performance statistics, comparison of the current production with the past performance, receipt and consumption of services and energy resources and daily analysis of performance.

Corporate production decision-making involves production planning and control (PPC). The first element of PPC is the order processing involving maintenance of current status of orders and despatch programmes, loading schedules on the basis of despatch outstanding, stock availability and logistic facilities, and preparation of despatch advices. The second element of PPC is the corporate production MIS indicated earlier. The third element of PPC is the material

tracking including maintenance of detailed production schedules through various stages of production operations (from initial loading up to the final finishing) ; preparation of inspection and tests certificates; scheduling of logistics facilities; preparation of production orders, based on production schedules; and in-process material and stacking report for all storage yards. The fourth element of PPC is the planning, including annual plans based on market demands; plant maintenance schedule and corporate plan requirements; quarterly and monthly plans based on annual plans and production targets; daily plans for fulfilment of monthly plans; comparison of plan versus performance at different time intervals; and preparation of subsidiary plans for requirement of raw-material, energy resources and finished inventory.

TISCO, TELCO, SAIL's Bhilai Plant and others have today incorporated PPC as part of their corporate MIS.

5.6 MATERIALS DECISION-MAKING

Materials accounting based on receipts, issues, returns, and rejections have been the part of transaction-processing system in all organisations so far. For the purpose of materials decision-making, comprehensive data-bases can have three components of purchasing , inventory, and materials review.

The purchasing data-base can help creating a corporate MIS for monitoring of purchase indents up to acceptance of tenders, monitoring of purchase orders against schedules of delivery, analysis of lead-time dealys, vendor-rating (in terms of quality performance of delivery schedule), and monitoring payments against deliveries.

The inventory data-base can help in creating a corporate MIS for preparation of standard specifications for regular consumption items, prompt inspection and acceptance of delivered goods, preparation of receipt documents, monitoring of stock balance, purchase dues, and indents dues; monitoring of procurement of regular consumption items, decentralised control of consumption, analysis of consumption and movement (particularly for slow moving and non-moving) of items for control, forecasting and budgetary control of consumption and procurement and so on.

Materials review data-base can help in creating a corporate MIS for the on-going review of the variou. control parameters such as re-order level, re-order quantity, the phasing of deliveries for 'A' class items, the bulk purchasing of 'B' and 'C' class items, and so on. Basically, materials review should look critically at all the expected norms of purchasing and inventory so that a dynamic adjustment is possible before the on-set of any crisis.

5.7 MAINTENANCE DECISION-MAKING

Maintenance management distinguishes between preventive maintenance and break-down maintenance. While preventive maintenance can be planned. the break-down maintenance is invariably unplanned.

As regards plant preventive maintenance, the experience with oil refineries, industrial blast furnaces, dock facilities and thermal projects have all shown that a thorough planning and a scheduling of preventive maintenance can be immensely time-saving and cost-reducing.

Transaction-processing systems have looked at the records of components, spare-parts, fixtures and tools as inputs, and consumption statements and maintenance accounts as outputs. These inputs can still be valid for building up a corporate MIS with such additional data as equipment conditions, history of failures, direct cost of maintenance, inventory values and materials movement, man-hours spent, over-time paid, other resource usage, maintenance of workers' performance, reliability and maintainability of equipment, and maintenance contribution to unit manufacturing cost.

From such a comprehensive data-base, one can generate MIS reports for equipment control, such as equiptment register (to provide equipment specifications and project details), equip-ment history (to provide maintenance particulars), major failure report, forecast on mainte-nance (providing probable failure time and period), plant non-availability, plant reliability and maintainability, and maintenance schedules (providing maintenance activities to be done during a specific period). One can also generate MIS reports on work control, such as, craft performance report (providing planned and actual performance of each craft), craftman's performance report, maintenance planning efficientcy report (providing an efficiency ratio on planned activities), overtime report, resource levelling report (providing analysis of resource required job-wise), delay cause report, etc. One can finally generate materials control reports and cost control reports providing management details of costs and material transactions involved in maintenance management.

Activity D
Prepare a MIS report for equipment control in your organisation.

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5.8 SUMMARY

This unit provides a brief account of the practice of computer-aided decision-making in such selected functional areas as finance, personnel, marketing, production, materials and mainte-nance. Some of the areas left out are project, medical and health care, township, training, fire service, energy and industrial engineering. These all have similar needs to build up from basic inputs a good quality data-base each and then to evaluate selective data, analysed data, inter-linked data and aggregated data to derive suitable MIS support to decision-making at the corporate level. The practice is becoming more and more endemic in the Indian environment and the proliferation can only be beneficial to the management in the long run.

5.9 SELF-ASSESSMENT EXERCISES

1. Evaluate the role of computers in Management Decision-making.
2. Examine the advantages of Computerised Management Information System vis-a-vis a manual MIS.
3. Evaluate the existing Management Information System (MIS) in your organisation. Suggest measures to improve it.

UNIT 6 COMPUTER BASED FINANCIAL SYSTEMS

Objectives

After studying this unit you should be able to:

● define what are various aspects of financial systems

● identify problems associated with computerisation of financial systems

● design some financial applications for computer implementation

● design spreadsheet for financial applications.

Structure

6.1 Introduction

6.2 Financial Systems

6.3 Financial Management Software

6.4 Computer Aided Financial Planning

6.5 Summary

6.6 Self-assessment Exercises

6.7 Further Readings

6.1 INTRODUCTION

Historically, operations such as accounts payable, cost accounting and financial statement preparation were among the first to be automated, via punched cards systems in the 1930s and 1940s and on computers in the 1950s and 1960s as in pay-roll procedures. These functions are largely routine, relatively easy to automate. The benefits offered by such applications traditionally have been in the form of clerical cost reduction, and although they have not normally led to dramatic increase in profitability, they have produced sufficiently large savings to more than justify their computerisation.

In spite of the traditional nature of accounting and finance applications, several sophisticated, high benefit systems are being implemented in this administrative and business area. Cash management, financial modelling and advanced purchasing systems are three examples of the new interest in accounting and finance applications.

In large, diversified, or widely dispersed organisations, the management of cash resources is a difficult job, yet one that has a large impact on profitability. Failure to invest temporarily available cash, premature payment of obligations, or short-sighted investment programmes that force an organisation to borrow at high rates, all result in less than optimal use of financial resources. In an attempt to avoid these problems, many large organisations are using computers to help collect, analyse and report data about cash requirements and reserves. The benefits of such systems include less frequent and smaller short-term loans, lower rates of interest, and higher returns on short-term investments.

Financial analysis of proposals is the second area where computers are playing an increasingly important role. Relatively straightforward simulation models enable the financial manager or

analyst to generate pro forma statements that show the financial impact of different proposals, such as adding a new product to a current line or opening a new warehouse. The advantage of such models is that many possible outcomes can be evaluated in the time that one or two could be calculated by hand.

Advanced purchasing systems are the third area of current interest. Computer-based systems monitor the data about price and quantity discounts, product quality and reliability, and speed of delivery. On the basis of these data, computer programme can calculate vendor rankings and economic purchase quantities for individual items and store product information that helps buyers evaluate vendor performance and negotiate favourable contracts with suppliers.

Table 1 lists many of the traditional accounting and finance applications as well as those of high current interest.

Table 1
Finance Systems - Computer Applications

Applications	Least Complex ....Most Complex		
General Accounting	●Cost record keeping	●Cost accounting comparison to standards or projected amounts ●Budgetary accounting ●Daily exception reporting	●Cost estimating
Accounts Payable (A/P)	●Preparation of A/P registers ●Check processing ●Check reconciliation ●A/P distribution		
Purchasing		●Vendor analysis-Volume purchase ●Purchase order preparation and follow-up	●Vendor analysis-Quality ●Knowing Economic purchase quantities ●Requirement	●Make or buy Analysis ●Analysis of financial proposals

Financial statement preparation	Planning e.g. cash management system Maintenance of shareholders records

6.2 FINANCIAL SYSTEMS

These systems are primarily concerned with recording business transactions in respect of wages and salaries, purchases, sales and other aspects of income and expenditure, both capital and revenue. Records of such transactions provide basis for the preparation of periodic or annual profit and loss accounts and balance sheets.

As can be seen, the financial systems of a business are, effectively, accounting systems which are often structured as separate systems to the non-financial systems. When systems are computerised, the separately structured systems are often integrated for economy of data processing and administrative efficiency.

Functions of Financial Systems

One of the most important functions of financial systems is to ensure that all business transactions are recorded in proper books of account, on the basis of recognised accounting practice. Such accounting transactions are largely for purpose of custodianship, as a public limited company is responsible to the shareholders - the owners of the business and accordingly it is essential that the business records potray a true and accurate record of profits and losses, assets and liabilities.

Other functions of financial systems are summarised below:

- Planning and controlling all expenditure, both capital and revenue
- Controlling the receipt and payment of cheques, etc. relating to busines. .ransactions and relevant banking transactions.
- Safeguarding the assets of the business in respect of plant and machinery, stocks, debtors and cash
- Maintaining statutory records as per Government's regulations
- Preparation of periodic reports for statistics, performance and results for internal control and audit.

Activity A

How are the above functions being performed in your organisation? Record your perceptions about them, function-wise, choosing one of the alternatives given below regarding their performance.

(i) Satisfactorily (ii) To some extent satisfactorily (iii) Not satisfactorily

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Activity B

What would you suggest to make the system more efficient?

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6.3 FINANCIAL MANAGEMENT SOFTWARE

The micro computer can provide a new and very efficient tool to improve the service. For example, it can transform efficiency by replacing a large amount of manual record-keeping and, perhaps more significantly, it can extend the quality of the service being offered. After introducing a computerised sales ledger, the regular balancing of the ledger (itself a considerably easier task using a controlled computer system) will be accompanied by the printing of an 'aged' list of balances. From this report the accountant can initiate and monitor a follow-up routine to recover any overdue amounts. In this and similar situations the firm will be offering a much more powerful financial control system that combines the interpretative skills of the accountant with the routine efficiency and analytical capabilities of computerised ledger systems.

Much of the software available for the practising accountant will, of course, also be of use to his clients as well as to other professional firms. Although some features may be required specifically for the accountant, his management control needs will be very similar to those of

other businesses or practices so most programmes offered are described in their publicity material in ways that illustrate their widest possible use, including uses for which they may be only marginally suited. Some of the most widely-used financial management software can be listed as:

- General Ledger ⎤
- Sales ledger ⎥ Stand alone or integrated,
- Purchase ledger ⎥ incorporating budgetary
- Invoicing ⎦ control and management accounting
- Stock control
- CCA adjusted accounts
- Pay-roll
- Modelling techniques

Figure 1: The General Ledger
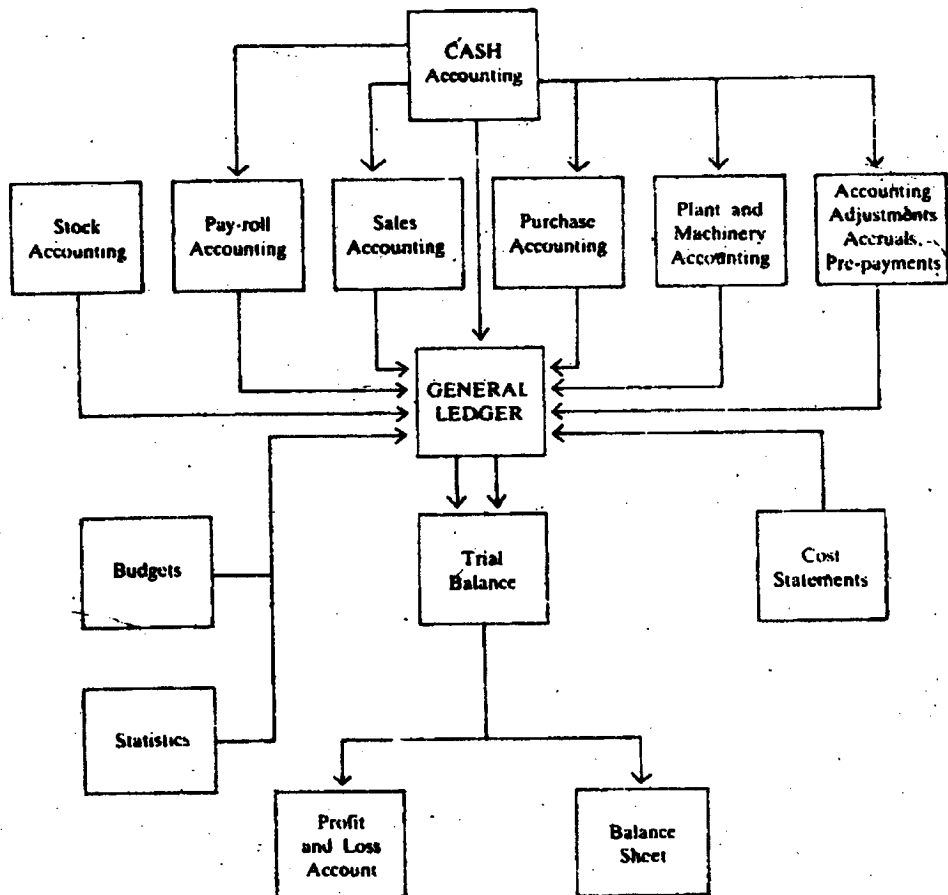
General Ledger

The focal point of financial accounting systems in the general ledger is sometimes referred to as the nominal ledger. The nominal ledger consists of accounts in which transactions are recorded from the point of view of business and these are classified as 'impersonal accounts'. Impersonal accounts are sub-divided into 'real accounts' and 'nominal accounts'. Real accounts are concerned with the tangible assets such as plant, machinery and buildings, whereas nominal accounts are concerned with expenses, income, profits and losses. Financial accounting sub-systems are directly related to the general ledger by way of double entry convention for recording of business transactions. In respect of the purchase accounting system, the general ledger contains the purchase ledger control account and account from different classes of purchases. The Sales accounting system has accounts in the general ledger by way of Sales Ledger control account. Similarly, the wages and salaries accounting system has the wages and salaries control account in the general ledger.

Cash transactions, in respect of the sub-systems indicated above are effected in the general ledger: for cash receipts from customer, they are recorded in the Bank account and the Sales ledger control account (Figure I).

Computerised General Ledger Systems

The General ledger system on computer can be implemented as an integrated system to form a total system-by combining a number of related sub-systems for the purpose of improving administrative efficiency. Figure II describes the system run chart for one of the general ledger systems.

We shall briefly mention the main features of a computerised general ledger system which are easily available in the market:

● Automatic double entry accounting

● Accruals and prepayments are automatically reversed in the next accounting period

● The general ledger is maintained as a data-base and the Analysis Printing Programme can report in any sort, sequence and in many reporting formats which can be stored on computer

● When linked with the purchase ledger, standard monthly postings can be made automatically

● A history file of all the transaction records can be maintained so that analysis and schedules can be produced at the year end

● Profit or Loss statements, Balance Sheet and operating statement for the management can be produced

● Budgetary control can be exercised producing variances from Budget

● Budget flexing enables budgets to be altered by percentage changes, and produce financial projections as a result of the change

● Nominal accounts can be reanalysed into cost or profit centres, producing reports in up up to seven different types of sort keys

● A year end report produces summary of each nominal account for each accounting period, compared to budget and or previous years.

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Figure II illustrates computer runs for a general ledger system which is based on the outline Figure I. The input to run 1 is derived from data produced by the separate computer applications in respect of transactions relating to stocks, pay-roll, sales, purchases, plant and machinery including depreciation, accruals and pre-payments, accounting adjustments and cash. The transaction data in respect of each application is assumed to be stored on magnetic tape. Run 1 is concerned with consolidating all nominal ledger data and this is achieved by merging all the relevant transactions on the general ledger codes. The output from Run 1 is a consolidated file of transactions, which is input to Run 2 for updating the general ledger file. This file is stored on magnetic disc to facilitate direct access to relevent general ledger account codes. Run 2 also produces a list of detailed postings to each account.

At the end of the month, the general ledger file is input to Run 3 to produce a Profit and Loss Account and Balance Sheet. The general ledger file is also input to Run 4 together with a budget file which is updated with actual expenditure providing the cumulative expenditure to date for comparison with budgeted expenditure. A variance report is then printed for analysis by respective cost centres.

Incomplete records: This complex area has been a prime target for the development of computer programmes and these are available on most of the popular micro-computers. A typical package will hold between 250 to 900 nominal account headings and between 2,500 to 4,000 transactions. The routines for posting the transactions will be so structured that each prime entry source will be posted automatically to the respective nominal account.

Nominal account codings can be defined to suit each client. The format of the accounts can be used to provide an outline sequence within which to create the accounts code list. It is advisable to allocate the codings in blocks that will allow additional accounts to be opened without destroying this sequence. It is impossible to define this structure without knowing the coding facility of a particular package or the requirements of the client. One example using a four-digit structure could be as follows:

General Ledger	Accounts Codes
1000	Fixed assets
2000	Current assets
3000	Current liabilities
4000	Capital
5000	Reserves

Within each group up to 999 accounts might be available to allow for the detailed analysis. With the Reserves group (in the illustration the 5000 series), more numbers are available to be

PAY-ROLL ACCOUNTING SYSTEM

CASH ACCOUNTING SYSTEM

PLANT AND MACHINERY REGISTER

STOCK ACCOUNTING SYSTEM

SALES ACCOUNTING SYSTEM

PURCHASE ACCOUNTING SYSTEM

ACCOUNTING ADJUSTMENTS AND PRE-PAYMENTS

STOCK   PAY-ROLL   SALES   CASH   PURCHASES   P & M   ADJUSTMENT

Transactions

RUN 1
MERGE TRANSACTIONS BY GENERAL LEDGER CODES

MERGED TRANSACTIONS

GENERAL LEDGER MASTER FILE

RUN 2
UPDATE GENERAL LEDGER, PRINT TRANSACTIONS

TRANSACTIONS APPLIED

RUN 3
PRINT PROFIT AND LOSS ACCOUNT AND BALANCE SHEET

PROFIT AND LOSS ACCOUNT

BALANCE SHEET

BUDGET FLEXING FACTOR

RUN 4
UPDATE ACTUAL EXPENDITURE COMPARE WITH BUDGET PRINT VARIANCE REPORT

BUDGET FILE

VARIANCE REPORTS

allocated to revenue and expenses items to be identified in the profit and loss account. In this latter case, the series numbered 6000 onwards could be used to create a profit or cost centre analysis within the profit and loss account.

A common feature of many of these packages will be the automatic calculation of depreciation using preset depreciation parameters. Reports generated will usually include:

● Trial balance
● Bank and cash reconciliation
● Adjustments analysis
● Fixed asset schedule
● Nominal ledger accounts in detail
● Profit and loss account
● Balance sheet
● Source and application of funds.

Most programmes now offer perhaps the most useful facility of all, namely the preparation of a full set of final accounts, including notes to the accounts and the director's report. However, it must be said that some systems will not print to a particularly high standard and you may be unable to use the printout from the machine for presentation.

Integrated purchase/sales/general ledger: There are several packages available which offer the above reports either as individual modules or as an integrated system. One of these has been already discussed earlier. In addition, systems are now offered which link the sales and purchase ledgers to a stock control programme, and the sales ledger to an invoicing programme. Most systems offer either 'open item' or 'balance brought forward' on each account. Naturally, the open item system offers a more comprehensive service - balance brought forward being ideal for smaller businesses whose accounts are cleared monthly.

The system will create the double entry within the general ledger for all postings through the sales and purchase ledgers. Journal entries to the general ledger will only be accepted if the debits and credits equate to zero, as will input through the purchase and sales ledger, thereby ensuring that the trial balance must always balance. Additionally, pay-roll and job costing may be linked to the general ledger to produce final accounts and other management information.

All inputs to the system will be via the Visual Display Unit (VDU) with the screen not only displaying data keyed to the system but also instructing the operator on the next step to be taken or reporting any errors that may occur. Input of data is normally through a batch posting system, using a check-digit total for each batch to ensure accuracy.

Other financial Systems

A typical system will offer around 800 accounts and 4,000 to 6,000 postings per month. It will hold details of customer's accounts and register all sales transactions. Initially, the user will be presented with a 'menu' of the various routines available from which the required routine is chosen, as shown in Figure III.

YZ Limtied	Sales Ledger Menu

SALES LEDGER

Press tne required number

1   Master file update

2   Master file print

3   Batch posting

4   Account enquiry

5   Cash allocation

6   Month end routine

The customer master file will hold the name, address and telephone number, credit limit, account balance 3 to 4 months old, turnover statistics, sales territory codes etc. The transaction file will hold details entered into the system together with all invoices, credits, adjustments and cash items posted during the current financial periods.

6.4 COMPUTER AIDED FINANCIAL PLANNING

Plans have a central role to play in a company's decision-making process. To do this effectively they often need to present a number of alternative evaluations based on different assumptions and different ideas for new projects, product introduction and the like. Here, then, is the fundamental defect of manual planning and budgeting methods, a defect which can often be overcome by the use of computerised methods. The plans, to be of any use, must be easy to produce answers in a number of 'what if?' formats:

'What happens if we give an extra discount of 5 per cent for orders over Rs. 1,000 resulting in increased sales volume of 2 per cent?'

'What happens if it only gives 1 per cent extra?'

'What if we keep the old version going for a further year and hold the price, at the same time deferring its replacement and putting in Rs. 1,00,000 more for development?'

'What if we open a new warehouse in Bhopal in two years' time which takes 10 per cent of the volume from Delhi and 25 per cent from Bombay while sales go up by 15 per cent in each region and how full will the three warehouses be?'

'What does the picture look like if we run all three ideas (above) together next year?'

'What will change if we defer the new warehouse for a further year?'

'What if we put on a second shift with a 30 per cent premium on wages but at the same time stop all production overtime?'

Given a calculator, large sheets of paper, the basic information and peace and quiet, any one of the above questions could be evaluated by most accountants or managers. The work is quite straightforward. It would not be so easy to find the time to work through all of them. But this is a scenario familiar enough in most companies, and often it results in decisions having to be taken without an adequate evaluation being completed. This is not so because there is, as is so often alleged, 'a lack of information on which to base the decision' but rather because there is insufficient time to work through all the options with pen and paper.

Other difficulties with manual systems, which admittedly can be partially alleviated by use of the more sophisticated types of calculator, include working out discounted cash flows and other types of evaluation of returns on investment. A computer, however, will drastically reduce the time taken.

Figure IV: COMPUTERISED SPREADSHEET—AN EXAMPLE

1 A	B	C	D	E	F	G	H	I	J	K	L	M	N
					CASH PROJECTION								
2	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
3 CASH RECEIPTS													
4 Small Builders	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Distributors	0	0	0	0	0	0	0	0	0	0	0	0	0
Private Customers	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Others	0	0	0	0	0	0	0	0	0	0	0	0	0
8													
9 TOTAL RECEIPTS	0	0	0	0	0	0	0	0	0	0	0	0	0
10													
11 CASH PAYMENT													
12 Timber Suppliers	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Misc. mat Suppliers	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Wages	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Rent and Rates	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Other Overheads	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Interest	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Drawings	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Tax Payments	0	0	0	0	0	0	0	0	0	0	0	0	0
20													
21 TOTAL PAYMENTS	0	0	0	0	0	0	0	0	0	0	0	0	0
22													
23 Opening Bank O' Dft	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
24 Total Receipts	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Total Payments	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Closing Bank O' Dft	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400

Lastly, once a range of options has been worked out, they need to be looked at from a variety of points of view, normally covering their impact on:
a) profitability
b) cash flow
c) capital requirements
d) balance sheet.

This in turn brings about a need for a great deal of further work if the full picture is to be collated each time the plans are in any way changed, and further underlines the fact that such an exercise is unlikely to be completed adequately, if at all, with manual methods alone.

Solutions offered by computers: Computers offer a variety of solutions to planning problems. They are often referred to as 'number crunchers', and this is very much the job they do when used in any planning application. But the use of computers in planning still leaves a number of other problems unchanged. The relevant information for input to the planning activity still has to be available in a suitable form. Chaotic accounting and control systems will not be of much use in providing it. The onus is still on management to think up new projects, ideas and products to bring the plans to life. Assumptions still have to be made about everything from the likely rate of inflation to the possible markets.

Without innovative thinking, there can be no plans, computerised or otherwise. Before they can form part of the plans, projects and ideas have to be investigated and costed. There is still a great deal of this and other preliminary work to be done manually. The computer's role is to take over the calculations, and allow a very large number of options to be evaluated in a very short time.

Spreadsheet Packages

In recent years, the single most successful package developed for micro-computers is the spreadsheet planner application. There is now quite a range of spreadsheet packages for IBM PC including the original Visicalc, and several packages which offer more. Both MBA from the Context Management system and Lotus's 1-2-3 offer graphing capabilities as well as spreadsheet calculations. Multi-plan is another spreadsheet package offered by Microsoft.

All developments of spreadsheet extend the simple concept of column analysis paper consisting of a few rows and columns to the limits of available micro-computer capacity with facilities to edit and calculate rapidly (a common size is 63 columns and 254 rows). Each column is usually identified by a letter combination A, AA etc. and the rows by numbers 1 to 254. So any individual position in the worksheet or cell can be identified by its column letter and row number e.g. A1, B24 etc. This facility enables relationships between cells to be defined e.g. cell A4 equals sum of cells A1 and A2 and A3 or cell D4 equals A4 multiplied by B4. Once a data model has been built up from such relationships, data can be inserted in some cells and the dependent values will be automatically calculated and made available for display. Any change to an entry value will be reflected immediately in regenerated results. The range and complexity of spreadsheet planning models is enormous and its flexibility in business applications is only constrained by the imagination of the user. A sample spreadsheet is shown in Figure IV.

Interfacing accounting and planning software: There is one way in which computers can simplify the information-gathering process itself. This is where computerised accounting systems are being operated in the company where the planning is to be done. But obtaining information from such a source is not as simple as it might appear at first sight.

There are plenty of micro-computer packages (pre-written programmes or 'software') available for accounting work, covering such things as sales, general ledgers, invoicing, stock control and sales order entry. If the same micro-computer is to be used for both planning and accounting, a special link will normally have to be made between the two types of application (accounting and planning) in order to pass the data from one to the other. This 'interface' will normally be in the form of a programme, and the programmer will require detailed knowledge of how the accounting programmes are structured in order to know where the required information is held and what form it is in and to work out how to get at it. As the vendors of package software are usually reluctant to divulge such details for fear of piracy, the interface will often need to be programmed by the suppliers of the accounting software. They, in turn, may be unwilling to undertake such work or it may be very expensive. Either way, they will have to become familiar with the planning software as well. Such links, therefore, are not altogether straightforward, although some of the publicity material put out by the micro-computer manufactures can lead one to believe that the whole area is quite simple. If, however, the accounting software includes some form of 'report generator', this may provide the basis of a solution that is easier to attain in practice. This type utility programme is designed to extract data from files of information in a form specified by the user, and so it may be possible to construct a file of accounting data that can be passed across to the planning.

Activity C

Develop an operational flow-chart of computerised financial planning systems in your organisation.

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6.5 SUMMARY

This unit has attempted to introduce various computer based financial packages.

We have identified various computer based application systems and discussed in detail about general ledger systems. We have also identified some problems encountered with their implementation.

Later we have examined computerised financial planning software and spreadsheet packages. We have also discussed problems of interfacing accounting and planning software.

6.6 SELF-ASSESSMENT EXERCISES

1 How the financial systems, facilitated by computer software, are important for economy of data processing and administrative efficiency?

2 Computers are often referred to as 'number crunchers'. Evaluate the statement in the context of financial planning.

6.7 FURTHER READINGS

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    Gower Publishing Co.: London

UNIT 7   COMPUTER BASED INVENTORY SYSTEMS

Objectives

After studying this unit you should be able to:

● define what is meant by'inventory and its characteristics

● identify the purpose of computerised inventory systems

● design inver'ory system files and their relationships

● to know what type of software packages are readily available in the market for inventory management.

Structure

7.1 INTRODUCTION

When we go to a super market, we take it for granted that the shelves will be well stocked with the goods we want. We expect the produce to be fresh, in good condition and reasonably priced. Most of the time, this is what we find.

However, the problems of keeping a super market supplied with the right goods, in the right quantities, in the right condition and at the right prices are immense. Goods are bought from a large number of suppliers. Some are delivered in bulk to warehouses by the dealers, while th perishable goods must be sold the same day they are delivered. All goods have limited she! life, and most are subject to health law regulations. As problems are caused by overstockin a super market or a warehouse as by understocking, any goc us which have not been sold by the expiry date must be destroyed resulting in wastage.

The costs of transporting goods from one place to another are very high. It is important tha delivery vehicles are fully loaded on each journey, and that the routes they take are as short a possible. The costs must be kept to a minimum in order to keep prices down. Small pric increase can lose large numbers of customers. For these reasons, large super markets have use computers for their inventory control.

This is a simplified example of inventory control as applied to the case of a super marke However, this becomes very complicated in case of a different situation, say, productic nvironment.

7.2 WHAT IS INVENTORY?

The terms 'inventory' and 'stock' are usually seen as being synonymous and are used to describe materials which can be identified at various stages of the transformation process in organisations. It is customary to divide inventory into three categories:

- Raw materials including components and energy
- Work-in-progress
- Finished goods.

It will be evident that one organisation's output of finished goods may be another organisation's raw material input. Statistics indicate that all over the world, in manufacturing and distribution trade, raw materials, work-in-progress, and finished goods represent approximately 25, 25 and 50 per cent respectively of total stock value. Though the effect on an economy of aggregate stock levels is significant, the issue of inventory management is primarily an organisational one.

Usually, the consequences of the physical presence or absence of stock are expressed in money terms, and it is in this respect that the effect of successful inventory management is measured.

The above apportionment of stock across raw materials, work-in-progress, and finished goods conceals the fact that there are marked differences according to industry, and organisations within industries. A case can be mentioned of capital goods industry where 60% of the total stock is raw materials and compare this with the consumer goods industry where only four per cent of stock falls in this category. Indeed, in this latter case a fourth area, the distribution system, was estimated to hold 56 per cent of total stocks. Evidently, the particular circumstances of the market will influence both the size and disposition of stocks.

As is the case with much of the operations area, accurate measurement of inventory is possible. The extent to which these are translated into accurate records depends on the systems used to capture and store data. The final step needed to provide a sound basis for effective inventory management is the manner in which the data are processed and presented for interpretation.

7.3 THE CHARACTERISTICS OF INVENTORY

A number of features of inventory, most of which are measurable, can be identified. An understanding of the following characteristics is an essential basis for inventory management.

Type

As stated above, three types may be recognised:

i)   Raw materials: these include components, sub-assemblies, and energy.

ii)   Work-in-progress: which is to be found at various stages in the production process, and which implies a measure of added value.

iii) Finished goods: these represent the output of the production process which remain until they are disposed of (ideally by sale to a customer).

Function

When inventory moves through the manufacturing process it serves different functions. Most importantly, it provides the Working Stocks so that there will be enough items for manufacture

and sales. This is also frequently referred to as Lot Size Inventory because of the usual need to order or provide in lots or batches. When the most economical lot size is used, it is referred to as the Economic Order Quantity (EOQ) or Economic Batch Quantity (EBQ). Management must also take account of the fluctuations resulting from demand and lead time by establishing Safety Stock. This is also referred to as reserve, buffer, fluctuation, or stabilisation stock. These functions will be examined at greater length below. If the firm sees prospects of increased sales or supply shortages or if the supply is subject to marked seasonal effects, it may increase its inventories with what is known as Anticipation Stock. The final function is Transportation or Pipeline Stock, which reflects a product's movement during the manufacturing process or shipment to a customer.

Demand

Demand is a measurement of the total requirement for a given item over a specific time period. However, inventory demand should be differentiated from sales or usages. For example, sales only measure those orders satisfied, but do not include demand lost because of stock-outs. The importance of this difference is readily observed in the preparation of a demand forecast. The accuracy of this forecast requires data based on the total historical demand which includes both the amount supplied and the amount back ordered or lost. While the actual differences between demand and sales or usages for most firms are small, an examination of the historical data must be made to determine if the difference is significant.

Management must not only study the rate of demand, but the nature of demand as well. Autonomous demand which originates from customer orders receives much more attention than the demand which arises when higher-level assemblies are required. In this case components are used only when actual assembly takes place, generally at intervals, as opposed to the more continuous rate of depletion of autonomous (independent) demand. Examination of the movement of stock items indicates that the pattern of independent demand varies from being almost constant to highly irregular.

Lead Time

The length of lead time directly affects the size of the capital investment in inventories. Inventory lead time can be broken into four periods: review, order, manufacturing or purchasing, and receiving.

The Review Period is the time period between reviews in a fixed interval system. This period is not found in an order point system. The Order Period represents the actual time required to review inventory status and prepare the appropriate order. The Manufacturing Period includes order processing and schedule time, any queue time, machine set-up time, plus the actual manufacturing time. The Purchasing Period includes the time involved in processing a purchased order plus the elapsed time between a vendor's receipt of an order and its actual arrival at the manufacturer's facilities. The last period is the Receiving Period, which represents the time needed to process incoming order. This includes inspection and storage time, plus the time required to log the order into the inventory control system, so that it may be used by manufacturing.

Cost

There are three types of inventory cost, which may be involved in balancing the conflicting objectives for inventory.

The first cost is the Ordering or Set-up Cost and includes the following bought-in-items:

i)   The cost of the actual purchase requisition by inventory control.
ii) The cost of issuing a purchase order and any follow-up time.(by the Purchasing Department).
ii) The cost of the Receiving Department's order processing (clerical etc.)

Set-up costs for manufactured items include the following:

i)   The cost of generating the manufacturing requisition by inventory control.
i.) The cost of planning, scheduling, loading and expediting the item by production control.
iii) Machine Set-up time.
iv) Any one-time cost (start-up, scrap, etc.).

The second cost is the inventory carrying cost, and includes all the expenses required to maintain a volume of inventory. This can be expressed as a proportion of the value of the inventory per unit of time.

The third cost is the Stock-out Cost, which includes all expenses from running out of stock. If expediting is not used, the stock-out would represent any backorder cost plus loss of profits due to lost sales. The backorder costs include any extra paper work that might have been required, loss of return on capital not received during the stock-out, and loss of customer goodwill resulting from failure to fill the order.

Although stock-out costs and customer service are of great in portance the former are difficult to calculate and as a result such estimates are made infrequently. The normal attempt to control stock-outs is through the adoption of service levels, although, as will be seen below, this approach involves an implicit estimation of the cost of being out of stock.

7.4 PURPOSE OF COMPUTERISED INVENTORY CONTROL SYSTEM

The main purpose of the inventory control is the monitoring of the stock levels and this is achieved by recording stock movements on stock records. Through these means the current inventory situation, including shortages, is available.

It must be appreciated that inventory forms a buffer to facilitate variations in supply and demand. As it often consumes a high proportion of working capital, it must be controlled in the most effective manner to achieve the following:
Avoidance of excessive stocks
Avoidance of excessive stock shortages
Optimising cost of ordering supplies
optimising cost of carrying inventory.

Inventory Control parameters
The control of inventory is achieved not only by recording inventory movements, but also by means of control parameters for each item of inventory. Examples of such parameters are:
Re-order level
Economic order quantity
Safety stock

Maximum stock

Average stock.

Inventory Applications

Because the manufacturing process in many organisations is highly cor.plex involving large inventory stocks, many departments and users also account for the largest portion of product cost, and even small improvements in its resource utilisaticn can generate large profits. Reduction of work-in-progress inventory, elimination of duplicate holdings and order status information that permits the identification and expediting ar some of the benefits gained from the computerised inventory systems.

Table 1 given below describes the kinds of computerised inventory applications used in order of increasing complexities. A prerequisite for computerised inventory system application is an item-coding that can be used for all sub-systems of inventory, bills of materials and purchasing records. At the simplest stage inventory accounting systems are implemented, followed by requirements generation (bills of materials) and physical inventory systems.

Table 1

Computer Based Inventory Applications

Least Complex Application	....		Most Complex Application
Weekly stock reporting with daily activity listings	Use Reporting	Requirements forecasting	Continuous updating of inventory
Item catalogue preparation	Requirements reporting	EOQ calculations	Automatic item status reporting
ABC Analysis (distribution by Value)	Time series requirements reporting		Automatic replenishment initiation (Purchase Orders)
Net return analysis	Listing of procurement requirements		
	Cycle count physical inventory accounting		

7.5 INVENTORY SYSTEM DESIGN-AN EXMPLE

Most modern businesses require some method of inventory control, whether they are involved in outside sales or need to monitor equipment and supplies for internal use. Beginning with this, we will design files for such an inventory system for a retail sales enterprise. This will give us an opportunity to know about inventory system files and data relationships.

General Design of Inventory Systems

Inventory systems generally require the use of several data files. One file, usually referred to as the master file, keeps track of the quality of each item presently in stock. In addition, it may

also keep track of the location of each item in the warehouse, the cost of the item, the reorder point, the quantity currently on order, and the name and address of the vendor the item is purchased from. This allows the user of the system to locate an item quickly, get a listing of goods that need to be ordered, create and print new orders automatically and perform other similar stock-control tasks.

Most businesses also like to keep track of each individual transaction that occurs within the business. Information on these individual transactions is usually maintained in separate data files called **transaction files**. One such file might keep track of individual sales transactions: to whom items were sold, when, for how much, and the invoice or receipt number. A second transaction file might maintain an on-going record of all new stock received. We can see the relationship between the master file and two such transaction files in Figure 1.

The transaction files maintain a history of all individual transactions involving the sale and receipt of goods, while the master file maintains the current status of goods in stock at any given moment by using information supplied directly from the two transaction files. In a sense, the master file is an up-to-date summary of all activities in the two transaction files.

Key Fields

Whenever we design a system involving multiple data files such as these, it is very important to define a key field that can be used to relate the various files to one another. A key field has the following characteristics:

● It is unique for every record (item) in the master file

● It exists in the master file and in the transaction files with the identical field name, type, and width.

Figure 1: Relationship of typical inventory system data files

```
                    MASTER FILE
                    Records:
                    Part number
                    Item name
                    Amount in stock
                    Cost
                    Amount in order
                    Location in warehouse
                    Vendor Information
                    Order Date
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SALES/ISSUES TRANSACTION FILE        NEW STOCK TRANSACTION FILE
Records:                             Records:
Part Number                          Part number
Quantity sold/issued                 Quantity received
Selling price                        Purchase price
Date sold/issued                     Date received
Customer name                        Vendor
Clerk name
```

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The key field in most software systems is an identifying code. In an inventory system such as the one we are designing here, this code is usually a part number: each item the store carries has a unique part number. Without the use of key fields, data can be very difficult to manage.

Inventory System Problem Definition

Our Inventory System will be designed to allow a small business to keep track of all goods in stock, goods on order, and the location of the goods store. Whenever the store decides to carry a new item, the item will be assigned a unique part number and added to the master file. The system will provide the user with reports of all goods in stock, items that need to be reordered, and items on order, and will automatically produce purchase orders.

The system will also allow the user to keep track of all individual sales transactions: items sold, to whom sold, salesperson, date of sale, and invoice number. Similarly, the user will be able to keep track of all incoming goods as stock is replenished. The individual transaction records from sales and goods received will be used to automatically update the stock status records in the master file.

Inventory System I/O Specifications: The primary output from the Inventory System master file will be reports concerning the status of the inventory, and purchase orders for restocking. A current-inventory report will display the part number, part description, quantity on hand, purchase price, location in warehouse, and quantity on order for each item in stock. A record report will list all those items that need to be reordered, and an on-order report will list all items currently on open order. Finally, the system will actually print the purchase orders when the user is ready to restock.

We will need at least the following input in the master file to develop all these reports.

Part number
Item description
Quantity in stock
Purchase price
Reorder point
Quantity on order
Location in warehouse
Vendor's name
Vendor's address
Date of last update
Date of last order
Quantity to order.

The system should produce a receipt for each sales transaction. The receipt should contain the part number, quantity, invoice (receipt) number, salesperson's name, customer's name, selling price, and date. So the sales transaction file will need to include the following:

Part number

Invoice number
Salesperson's name
Customer's name
Quantity sold
Selling price
Date sold
Whether posted.

And finally, the system must keep track of goods received, and produce a report showing the part number, quantity received, purchase price, date received, and name of vendor. So the new-stock transaction file will need to include:

Part number
Quantity
Purchase price
Date received
Vendor's name
Whether posted

Inventory System Files Design

We will use three data files to manage the inventory, the master file and two transaction files.

The Master File: The structure of master file, with a brief description of each field's contents, is shown in Figure II. You can use this information to build the Master File.

Figure II: Structure for the Master data file

Field name		Width	Contents
1	Part-No	5	Part number (key field)
2	Title	20	item description
3	Qty	4	Quantity in stock
4	Cost	9	Purchase price
5	Reorder	4	Reorder point
6	Or-Order	4	Quantity in stock
7	Location	5	Location in warehouse
8	Vendor	25	Vendor's name
9	Vendor-add	25	Vendor's address
10	Vendor-CSP	25	Vendor's city, state, PIN
11	Date	8	Date of last update
12	Order-date	8	Date of last order
13	New-order	4	Quantity to order

The Sales File: Next we will create a data file to keep track of individual sales transactions. Notice that in the Master file just created, the key field named Part-No. has one character of data type, and is five characters wide. Since this will be the field used for updating the Master file, the Sales transaction file must have an identical key field. The structure of Sales File is shown in Figure III. Field 8, posted, is a special field that will be used to determine whether or not a given transaction has already been recorded in (or posted to) the master inventory file, to keep transactions from accidentally being posted twice.

Figure III: Structure for the Sales data file

Field name	Width	Contents
1 Part-Number	5	Part number (key field)
2 Invoice-No.	6	Invoice number
3 Clerk	12	Sales person's name (or code)
4 Customer	12	Customer's name
5 Qty	4	Quantity sold
6 Price	9	Selling Price
7 Date	8	Date sold
8 Posted	1	Posted to master file yet?

The New Stock File: The third file in the system will be used to keep track of goods received to replenish stock. Again, since the master file will be receiving information from this file, we will need to include the key field Part-No. The structure of New Stock file is shown in Figure IV.

Figure IV: Structure for the New stock Data file

Field name	Width	Contents
1 Part-Number	5	Part number (key field)
2 Qty.	4	Quantity received
3 Cost	9	Purchase price
4 Date	8	Date received
5 Vendor	25	Vendor's name
6 Posted	1	Posted to master file yet?

Now that we have designed the Files for our Inventory System, we need to design the input menu (Screens).

We want to design the system to allow different individuals to perform the various major tasks. That is, the store manager will be responsible for managing the master inventory, placing orders, checking the status of goods, and so forth. Individual sales transactions will be entered by sales clerks at the point of sale, and incoming stock will be recorded by a stockroom clerk. In a sense, we will be using three separate but related systems, with the overall structure shown in Figure V.

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┌─────────────────────────────────────────┐
│                 MENU 1                   │
│                                          │
│                Inventory                 │
│                 System                   │
│                Main Menu                 │
│         1. Manage Inventory master       │
│         2. Manage  Sales information      │
│         3. Manage New stock information   │
│                   ·Exit                  │
└─────────────────────────────────────────┘
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MENU 2	MENU 3	MENU 4
Add new parts	Record sales	Record items received
Print reports	Print sales report	Print reports
Make changes	Make changes	Make changes
Update Master File		
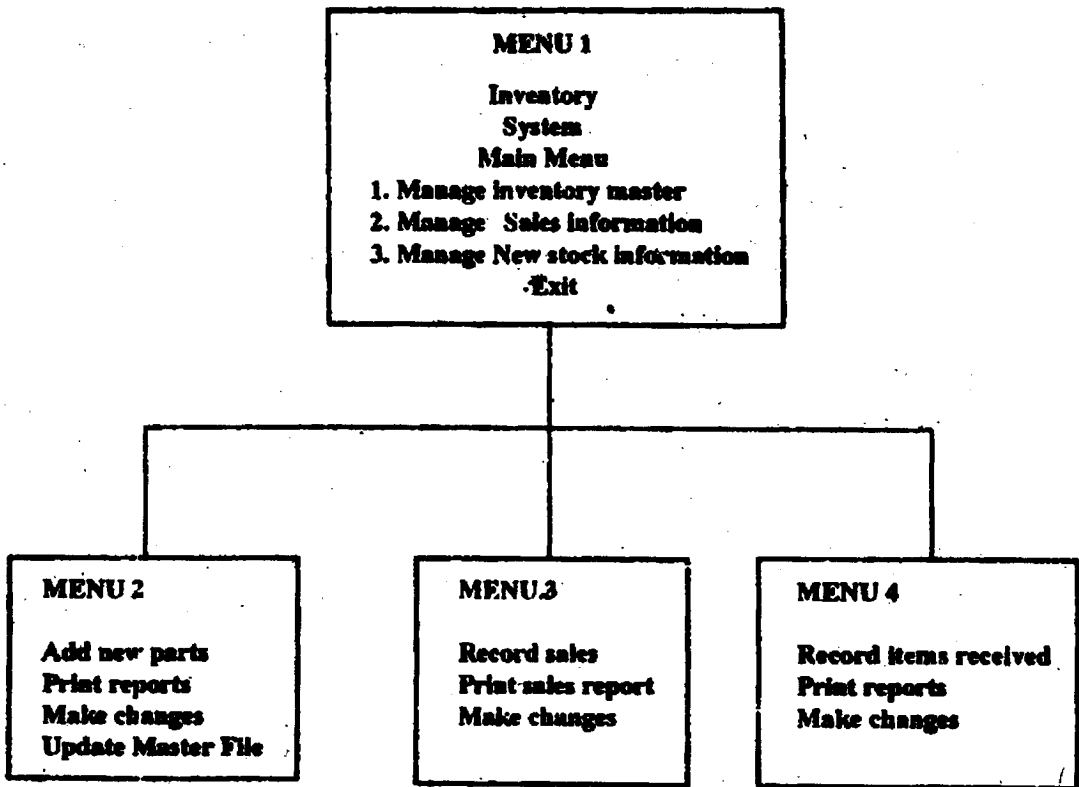
The inventory system can be simplified and its functions can be represented by four menus shown in figure V. the Menu 1 shall be overall inventory system menu. Depending on user's choice it would activate programme/sub-programme which would result in display of secondary level of menus e.g. menu 2, menu 3 or menu 4.

The main menu 1 would give the user access to Inventory, Sales or Stock master files. Use of secondary level menu shall provide user option to record new parts, print reports, amend the existing records. Suitable programmes can then be developed to perform the above desired functions.

Activity A

Prepare a flow diagram of the Inventory system in your organisation. Examine it in context of the I/O specifications and file design system described above.

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7.6 SOFTWARE PACKAGES IN INVENTORY MANAGEMENT

Table 2 lists some of the computer software packages which have been published in whole or in part, to deal with inventory management. The rates of introduction of new packages and modification of existing packages are high, so the details in the table are only indicative and only outline of the types of packages available is given.

The packages listed in the table are mainly derivatives of earlier software and are designed for implementation on mainframe computers. In general these packages offer a wide range of facilities, in addition to inventory management. Such commercially available mainframe packages often provide planning and control routines, purchase order processing etc., as well as inventory management.

Table 2

Name	Supplier	References
OMAC	ICL	
PCS	Burroughs	*Jour. of Industrial Engg,* March 1977
MAPICS	IBM	
IMS/66	Honeywell	*Jour. of Industrial Engg.* Jan., 1977, 79
CYBER	Control data	*Jour. of Industrial Engg.* Dec., 1977, 79
Industrial Management System 201	Mod Comp Business Systems	*Jour. of Industrial Engg.* Feb., 1977, 79
GIPSH Inventory Control and Replenishment system	Aston University	*International Jour.* of Prod. Reasearch 1980-81

There is, however, a move towards the development of micro-computer based yet comprehensive inventory management packages which provide not only for inventory record-keeping but also for decision making in uncertain conditions against required service levels. An indicative list of inventory management software available locally is also given below:

Name of the Package	Supplier	Operating system/Language
Inventory stock Accounting and Control System	Uptron Ltd.	UDOS, B-BASIC
Inventory Control	Par Computers Ltd.	MSDOS, CP/M, DBOS
Inventory control Computerised System	Datamatics Consultants Ltd.	Wang OS 6.3
Inventory Management System	Softscan Corpn.	APPLE-PASCAL
Inventory Module	Maegabyte Consultancy Pvt. Ltd.	CP/M, COBOL
Inventory Control	Eiko Sales Pvt. Ltd.	CP/M, BASIC
Inventory Monitoring System	NELCO	CP/M, BASIC
Inventory Management	IDM Ltd.	CP/M, MP/M, COBOL

There are a number of other inventory software available currently in India. Details of these can be obtained from software houses, computer dealers and other computer journals published. Most of the micro-based software are interactive and menu driven. They provide facilities for on-line entry of transaction and masters, validation of input data, stores ledger and stock status, consumption analysis and summary, 'exception reporting' for minimum level and reorder level.

Activity B

Briefly review the computerised Inventory Control System, evaluate their advantages and limitations in the context of your organisation.

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7.7 SUMMARY

This unit attempts to help you to understand computer based inventory application systems better.

We have defined the term inventory and its characteristics. Various computer based inventory applications have been discussed in terms of their complexities.

An example has been provided to design computerised inventory system files to establish data relationships. The example can be further developed by you to incorporate various reporting for outputs to the users.

A small indicative list of inventory packages has also been provided to give you an idea of what is readily available in the market.

7.8 SELF-ASSESSMENT EXERCISES

1. State and explain 'Inventory' and discuss its main features. Describe Lead Time and Demand forecast.

2. Read the following statements. Write True (T)/False (F) in front of them.

    i) Demand is a measurement of the total requirement for a given item over a specific time period;

    ii) Review, order, manufacturing and receiving periods are the part of demand forecast;

    iii) Order period represents the actual time required to review the inventory status and prepare the appropriate order;

    iv) Review period is the time period between reviews in a fixed interval system;

    v) Set up costs for manufactured items does not include the cost of planning, scheduling, loading and expediting the item by production control.

3. Discuss various applications of Inventory and its file design system.

Answer Key

Question No. 2

(i) T (ii) F (iii) T (iv) T (v) F

7.9 FURTHER READINGS

Clifton, H.D., 1986. *Business Data Systems,* Prentice-Hall: Englewood-Cliffs. (Chapter 10).

Lewis, C.D., *Scientific Inventory Controls,* Butterworth: London. (Chapter 8).

Moskowity, H. and G.P. Wright, *Operation Research Techniques for Management,* Prentice-Hall: Englewood-Cliffs. (Chapter 15)

Simmons, D.M., Optimal Inventory Policies Under a Hierarchy of Set-up Costs, *Management Science Applications,* 18, 10 June, B591-B599.

UNIT 8   COMPUTERS IN HUMAN RESOURCE MANAGEMENT

Objectives

The objectives of this unit are:

● to explain the various computer based information systems for human resource management

● to understand human resource management system needs

● to appreciate the main requirements for these systems.

Structure

8.1   Introduction
8.2   The System Needs
8.3   Designing the System
8.4   Uses of Computers in Human Resource Management
8.5   Software Packages in Human Resource Management
8.6   Summary
8.7   Self-assessment Exercises
8.8   Further Readings

8.1   INTRODUCTION

Every company has to develop a personnel information system to meet its own requirements. A system cannot simply be inserted into a company and expected to produce desired results. It is necessary first, to define what the system is intended to do, and then to examine what records and systems are needed to achieve this.

The purpose of a system will vary enormously according to the objectives of the company and may well have to be decided by senior management, leaving the application to the individual operating managers who will need to define their own information requirements within the broad framework of overall objectives. These could be any of the following:

● To support wage and salary administration
● To facilitate selection and appointments
● To help identify high potential people
● To determine in-company promotion
● To help in the administration of management development and training
● To help and develop full potential of employees and department.

The objectives of a system will change in the process according to circumstances. In the past for instance, determining wages has been the main purpose of employee information. Today such things as records of skills for manpower planning have begun to assume equal importance

8.2 THE SYSTEM NEEDS

Human resources management information systems are required for three main purposes:

1   To store the personal details of individual employees for reference.

2   To provide a basis for decision-making in every area of personnel work, especially in
* manpower forecasting and planning
* recruitment and selection
* employment, including promotion, transfers, disciplinary procedures, termination and redundancy
* education and training
* pay administration
* health and safety.

3   Supplying data for returns to government departments.

Personnel records and information procedures can be based on an entirely manual system but, increasingly, they are being computerised to a greater or lesser degree. The advent of microcomputers is accelerating this process.

A comprehensive system of records covers all the information required about individual employees or needed for personnel decision-making. But the information must be relevant. Every piece of information must be challenged with the questions 'What purpose will this serve?', 'To what use will it be put?'. The first point to clear when setting up a record system is the objective of each item in terms of the decisions it will help to make, its contribution to the assembly of essential statistical information, or its importance as a reference point in dealing with matters affecting individual employees.

It is necessary to avoid any gaps in information which is essential for decision-making. It is equally necessary to avoid gathering useless data or maintaining elaborate statistics to which no one ever refers. Too often, a 'one-off' request for information leads to the setting up of a permanent record or data collection system, although the information may never be requested again. Regular reviews should be made of all records and returns to ensure that they are serving useful purpose and that they are generally cost-effective. It may be cheaper in some circumstances to maintain manual records raterh than to computerise. It may be less time-consuming and costly to carry out a special exercise rather than to maintain a permanent record.

Identifying information requirements

The starting point should be an analysis of the decisions that the company makes or may need to make about individuals or groups of employees or the work force as a whole. This should be followed up by an analysis of the information required by government departments and agencies and by employers.

Human Resource Management decisions requiring statistical data

The main decisions for which statistical information or individual data may be required are:
* Forcasting the future supply of manpower by analysing, for each category of staff, labour turnover, age distribution, absenteeism and promotions

- Forecasting the future demand for manpower by ratio-trend analysis (calculating current ratios of manpower to activity levels and forecasting future ratios by reference to projected activity levels) and other statistical means

- The introduction of productivity improvement or cost reduction campaigns based upon analysis of present manpower productivity levels and costs (e.g. manpower cost per unit of output, or the ratio of manpower costs to sales turnover or profit)

- Planning recruitment campaigns on the basis of analysis of the results of previous campaigns, especially sources of recruits, media costs and success rates, and the relative pulling power of different inducements and recruitment methods.

- Introducing new or improved interviewing and testing techniques on the basis of comparisons between interview and test assessments and subsequent performance

- Identifying people with particular skills or potential for new appointments or promotion

- Improving disciplinary procedures or amending work rules by analysing disciplinary cases

- Introducing new or improved time-keeping methods or considering the introduction of flexi-time by reference to time-keeping records

- Planning redundancies-consulting unions, transferring or retraining employees, selecting employees for redundancy, helping to place redundant employees

- Planning training programmes-subjects to be covered, types of courses and number of courses-by reference to analysis of future changes in manpower (numbers and skills), performance review records and job and training specifications

- Taking steps to improve job satisfaction and morale by reference to statistics on labour turnover, absenteeism, sickness, accidents, discipline cases and grievances

- Charging pay systems on the basis of statistics of price index fluctuations in earnings, the proportion of employees on average earnings rather than payment-by results, cost per unit of output, fluctuations in earnings, the number and consequences of arguments over job rates

- Reviewing pay structures and levels of pay by reference to statistics of earnings in the company, rates of pay elsewhere, and the distribution of rates in each pay grade

- Controlling performance reviews by analysing the distribution of merit awards in relation to budgets and guidelines

- Taking steps to improve employee relations by analysing the causes of disputes

- Determining the information that should be communicated to unions and employees about the company or to assist in negotiations and joint consultation

- Improving health, safety and fire precautions by analysing reports on industrial disease, accidents and dangerous occurrences, monitoring returns on exposure to health hazards in relation to predetermined threshold limits, and studying reports on health, safety and fire inspection, spot-checks and audits.

Individual data

Individual information should include:

- The application form giving personal particulars
- Interview and test record
- Job history after joining the firm including details of transfers, promotions and changes in occupation
- Current pay details and changes in salary or pay
- Education and training record with details of courses attended and results obtained
- Details or performance assessments and reports from appraisal or counselling sessions
- Absence, lateness, accident, medical and disciplinary with details of formal warnings and suspensions
- Holiday entitlement
- Pension data
- Termination record, with details of exit interview and suitability for re-engagement.

Collective data

Collective information may include:

- Numbers, grades and occupations of employees
- Absenteeism, labour turnover and lateness statistics
- Accident rates
- Age and length of service distributions
- Total wage and salary bill
- Wage rates and salary levels
- Employee costs
- Overtime statistics
- Records of grievances and disputes
- Training records.

8.3   DESIGNING THE SYSTEM

The type and complexity of the personnel records of information system must obviously depend upon the company and its needs. Small companies may only need a basic card index system for individual employees and a simple set of forms for recording information on numbers employed, labour turnover and absenteeism. But a larger company will almost certainly need a more complex system because more information has to be handled, many more decisions have to be made, and the data changes more often. Card indexes are not enough, because supplementary records may be needed to give more detailed information about individual employees.

The key decisions to be made when designing the system concern:

● The design of the basic records, forms and input material

● The use of computers

● The extent to which records should be centralised or decentralised

● The procedures and programme for collecting, recording, updating and disseminating information.

The use of Computers: Advances in computer technology mean that relatively small firms can use computers, not only to store data but also to generate information for decision-making purposes. When thinking about converting manual records to a computer system or updating an existing system, the points to consider are:

1 Why computerise?

2 To what uses can a computer be put?

3 What systems should be selected and how?

4 How should the system be operated?

Computers will hold records in a more compact and accessible way, and they can be justified for this reason alone. They can generate information for decision-making more flexibly, more quickly and more comprehensively than any manual system.

8.4 USES OF COMPUTERS IN HUMAN RESOURCE MANAGEMENT

The main uses to which computers can be put in human resource departments are:

Keeping records: Replacing card indexes and filing cabinets by magnetic discs.

Listings: Quickly providing listings of employees by department, occupation, grade, pay level, length of service, age, sex, qualifications, skills, etc.

Automatic letter writing: Producing standard letters and forms for recruitment, promotion, transfer, upgrading, appraisal, pay review and new contracts of employment.

Manpower planning: Using manpower data to forecast the future demand and supply of people. Manpower models can be used, for the following: forecasting model for examining a hierarchy of grades by age. Useful for gaining a general understanding of future movement of staff and changes in age/grade structure.

Labour turnover analysis: Providing labour turnover statistics.

Career development: As a development of manpower planning models, computerised personnel information can be used to improve succession planning.

Recruitment: The computer can, in effect, be used as a filing cabinet to store details of each applicant, date of receipt of application, when called for interview and the outcome. If an applicant contacts the company, he can be informed of the progress of his application. Managers can be given details of the number of applicants and how many have been interviewed. Lists and automatic letters can be produced when calling for interview rejecting applicants or making offers.

Training: Records can be kept to check on who has received training or on progress through other training schemes. Listings of skills and qualifications by department or occupation can be produced to identify gaps and training needs.

Pay: Information can be drawn from both personnel and pay-roll systems to analyse pay-roll costs and ratios and to assess the impact of various pay increase options on the pay stucture and on total pay-roll costs. Budgetary control systems can be computerised to show actual pay-roll costs against budget and project future costs.

Salary administration: Salary analysis reports can be produced which give information by employee on occupation, salary position in salary range, total percentage increases over previous years and annual appraisal. Individual forms and departmental schedules can be generated for salary reviews and analysis can be made of the salary structure (e.g., compari-sons).

Job evaluation: Data bases can be created to hold and process the information on job evaluations, such as grades and point scores. Weightings of job evaluation factors can be computerised. In a job evaluation exercise, the information system can be used to point out the names of those whose jobs are to be evaluated. Details of job, grade, function, location, sample size and current point ratings can be programmed in. The data base can link together similar posts in different parts of the organisation. Listings of all gradings, re-gradings and points/scored can be produced.

Absence and sickness: Absence and sickness can be recorded by employee, with reasons and analysis can be produced of absenteeism and sickness.

Health and safety: Records can be maintained on accidents and absence due to health hazards. Trends can be analysed and information produced on who has worked in certain areas, or who has used certain processes and for how long.

Activity A
Critically evaluate the use of computers by your organisation for Human Resource Management decision-making, in the context of the diverse uses described in this unit.

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Activity B

What other activities would you like your organisation to take up for computerisation?

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8.5 SORTWARE PACKAGES IN HUMAN RESOURCE MANAGEMENT

Table 1 given below describes the kind of applications used for human resource management information system in order of increasing complexities. Historically, the payroll function was often the first administrative operation to be computerised. The highly repetitive nature of the job with well defined rules of computation, made it a logical target for automation, particularly since large number of clerical personnel were required to perform the function.

Table

Computerised applications for human resource management system

Least complex Application			Most Complex Application
● Pay-roll preparation	● Automation of basic Personnel data	● Salary Analysis	● Skills Inventory
● Cheques preparation	● Preparation of scheduled reports e.g.	● Performance appraisal	● Manpower planning analysis
● Production of required reports	- Seniority Vacations	● High-Flier tracking	

Table 2 gives an indicative list of sofware packages available in the market. There are a number of other software packages available in India for wide range of computer systems. Details on these can be obtained from software houses, computer dealers and other computer journals. Most of the above micro-computer based software packages are interactive and menu-driven which can also be customised to a limited extent at the customer's site.

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Table 2

Indicative List of Software Packages

Name of the package	Supplier	Operating system/Language
Personnel Inventory	Maitec Consultant	CP/M, DBASE-II
Pay-roll Accounting	....	....
Skills Inventory	MECON	COBOL
Manpower Planning	MECON	COBOL, FORTRAN

8.6 SUMMARY

This unit should have given you an understanding of a Human Resource Management Information System in an organisation. The unit identifies the specific needs and describes various types of data and software packages which might be usefully applied in a Human Resource Management Information System.

It also explains the main uses and design considerations of the computers relevant for an effective and efficient Human Resource Management Information System.

8.7 SELF-ASSESSMENT EXERCISES

1 How does computerised personnel Information System help in managing Human Resource more efficiently?

2 Evaluate your organisation's Human Resource Management Information System and suggest how to make it more efficient.

8.8 FURTHER READINGS

Edwards, C., 1982. *Developing Micro-computer Based Business Systems*, Prentice Hall: Englewood-Cliffs.

Moris, R., 1984. *Computer Basics for Managers*, Business Books Ltd.: London.

Perspective in Manpower Planning, Institute of Personnel Management (I.P.M.): London.

Springall, J., *Personal Records and the Computer*, Industrial Society/IPM: London.

Wille, E., 1981. *The Computer in Personnel Work*, IPM: London.

BLOCK 3   SOCIO-LEGAL ASPECTS OF COMPUTERISATION

This block discusses the socio-legal issues involved in computerisation and also examines the role plated by computer viruses.

Unit 9 on Social Dimensions of Computerisation identifies the major issues related to the use of computers in todays society.

Unit 10 on Computer Viruses gives an understanding of the different types of perverse or harmful computer software, their harmful effects and measures to counter them.

The eleventh and last unit in this block on Legal Dimensions of Computerisation highlights the interfaces between todays computer world and the law.

UNIT 9 SOCIAL DIMENSIONS OF COMPUTERISATION

Objectives

After studying this unit, you should be able to :

- identify major issues related to the use of the computer,
- explain how the computer has affected the individual in his pattern of life habits and thinking,
- explain how computers can affect the society at large beneficially as well as harmfully,
- examine the impact of computers in the context of Indian society in a limited way.

Structure

9.1. INTRODUCTION

Computer Technology has come to stay in our country. While the developed countries have moved to an extent that the computer has become part of every man's life, in India the impact of the computer technology can be felt only in certain fields. Seeing the pace at which the technology is spreading in our country, it may look rather out of place to raise such questions as whether we should adopt this technology at all, or should we adopt it selectively etc. Yet, as in the case of ecological and environmental aspects of fields such as energy, industrial production, urbanisation etc., which are hotly debated all over the world, the environmental impact of the computer technology also needs to be looked into. It is in this background that the social, political, organisational and individual impact of computer technology are discussed in the following paragraphs. Both the beneficial and harmful consequences of the technology will be discussed.

9.2 THE INDIVIDUAL AND THE COMPUTER

Beneficial Impact

Some of the benefits which an individual derives from computerisation are as follows :

- At home, in the workplace, the drudgery of repetitive type of operations is avoided.
- Speed of processing helps quicker, more timely decision making.
- To such professionals as researches, scientists, engineers etc., the accuracy provided by the computer is of immense value.
- As a customer he receives quicker service.

The computer combined with electronic communication devices makes life easier for the individual in many fields such as reducing or even eliminating costly travel, shopping from home, getting news from any part of the world instantaneously etc., all of which are very valuable to the businessman and industrialist.

The advances in medical diagnosis etc., can come to the help of every individual.

Harmful Impact

The individual's dependence on computer can cause untold miseries, if for some reason the data which he had fed into the computer were to be lost without a back-up.

He may cease to use his brain for commonsense arithmetic so that, he may lose his numerical ability.

The individual becomes so transparent to the whole world through the storing of information about every aspect of his life in many places thereby losing his privacy.

The individual may suffer from the use of inaccurate information kept about him in the computer. There is also likelihood of such information being misused to his disadvantage.

Every individual becomes the potential victim for the consequences of computer controlled decisions in such strategic areas such as use of atomic and other potentially dangerous weapons and gadgets.

An individual who is not inclined to learn about computers may find himself treated as a second class citizen in certain contexts.

Every individual who is a wage earner may find his services superflouous, with the computer taking over his work and thus making him at least temporarily out of job.

The effects of radiation, harmful effects from the continuous exposure to the V.D.U. etc., may also affect some individuals.

9.3. THE COMPUTER AND ORGANISATIONS

Beneficial Impact

All the benefits which a computer affords to an individual are available to organisations also, perhaps several-fold.

The management process, which tries to substitute rationality in decision making using timely, relevant and accurate information, is greatly facilitated by the computer.

Tremendous gains in financial control, inventory control, market control etc., are possible using the computer technology. In factory production quality control, production planning and monitoring etc., are made more effective and easy with the help of the computer.

Organisations can move into higher levels of forecasting using such techniques as simulation, and also benefit by the use of various O.R. techniques with the help of a computer.

The horizons of organisations themselves are widened with the help of computers combined with modern electronic communication facilities

Harmful Effects

Many organisations have and continue to invest in the technology without sufficient systems analysis, and without preparing the ground properly for implementation. This results in various kinds of frustrations in such organisations.

The mix of skills needed in the organisation undergoes major change which may create lots of tensions and may harmfully affect the human resources.

When computers take over many items of work from human beings the organisation may find itself loaded with unwanted manpower. This can lead to a lot of industrial strif

The employees start living in continuous fear of being declared redundant and lose morale and motivation.

The distribution of power in the organisation gets altered with attendant struggles for regaining power through unhealthy ways.

The noncomputer skilled people may find themselves treated as second class citizens in the organisation.

New and devious way of misuse of the computer technology may be found to defraud the organisation.

The organisation becomes transparent and may suffer at the hands of competitors.

The dependence on computers for handling information can lead to several embarrassments and even losses when there is a failure of the system.

Large investments in hardware and software are required to use the technology which may not yield immediate returns.

9.4. THE COMPUTER AND THE SOCIETY

Benefitial Effect

The harnessing of natural resources is facilitated in quicker and more effective ways by the use of the computer technology.

Public services can be made more effective with the help of computers which is a perennial problem faced by every society.

The flow of information and communication channels provided by computers together with modern communications facilitates the removal of barriers among different societies and can develop global brotherhood.

Members of the society acquire many conveniences which take away the drudgeries and tensions of living in metropolitan areas.

The scientific advancements especially in the areas of medical science, weather forecasting etc., are of tremendous value to society.

Harmful Impact

The unemployment problem posed by the adoption of computer technology compounds such other phenomena like recession and leaves the society in great turmoil.

New divisions in society based on the extent of knowledge and skills in the use of the technology get created posing new problems.

Hitherto unimaginable potential for misuse springs up leaving the society in fear of such misuses and frauds.

The use of computer in strategic areas like defence, atomic science etc., leaves the society in fear of catastrophic consequences either due to program errors or due to deliberate act of bias.

There is fear that future children and growing children may lose all their commonsense abilities, especially numerical ability by total dependence on computers.

9.5. THE COMPUTERS AND THE INTERNATIONAL SCENE

Beneficial Effects

The frontiers of nations and countries have shrunk a great deal by the quantity and speed of communication that has been facilitated by computer and communication technology.

Computer conferences, tele conferences etc., using satellite communication has changed the complex of business across nations and a new globalisation process has set in.

The cause of research in scientific areas has been advanced.

Harmful Impact

Computer technology has titled the balance of weapon power in favour of certain countries like USA through the use of computer and communication technology.

The gap between poor nations and rich nations has increased in one more dimension, namely the computing power. At will or even by accident rich nations can in a split second blast accurately several capitals.

The long debates and pressures brought about on developed countries on the question of super computers is evidence of how a technology can be used to pressurise developing nations.

9.6. THE COMPUTER AND POLITICS

Beneficial Effects

Data processing in census, elections etc, have helped a great deal in making these operations related to political activities more data-based, quick and efficient.

The computer and communication technology has made election result processing and its communication all over the country more effective.

Even though still under debate the use of computerised voting machines can make the election process less amenable to muscle power interventions.

The computer has helped many a parliamentarian to use information effectively to support his contentions. The whole parliamentary process can in due course be more data-based and less emotion-based.

Harmful Effects

When the opportunity for processing information through computers is not equally distributed and also when the awareness of the potentialities of its use is also low some politicians can twist information for various parochial ends.

Trade union leaders are opposing the use of computerised information technology, especially in organisations which provide employment to a large number of white collar employees.

9.7. THE INDIVIDUAL AND THE IMPACT OF COMPUTERS ON HIS LIVING STYLE

An individual who is a professional say a doctor, engineer, architect, businessman, consultant etc., undergoes a substantial change in his working pattern when he takes to a computer. The computer helps him to process information more quickly and effectively which in turn upgrades the quality of his work and makes him more self-confident. He also ventures to examine more alternatives, do more comparisons and applies more of his thinking and analytical capabilities, as against his preoccupation with data processing. Thus the computer enables the professional to become more competent.

An individual who is a member of an organisation also can, when he is making use of a computer, become more competent in his field. However an organisation means a lot of people with different needs at different levels and under different circumstances and therefore subject to a variety of forces in the organisational context so that the actual growth of an individual in an organisation using the computer technology will depend on many things other than the opportunity to avail the technology.

An individual who is a researcher either in physical sciences or social sciences is perhaps more benefited from the use of computers. In processing data, in getting accuracy, in controlling flow of chemicals etc., in simulation etc., the computer offers enormous potential.

The common man in general is also affected by the computer even though he himself may not have access to a computer. He is the recipient of both the beneficial as well as harmful effects of teh computer technology. In many public services like railways, airports, employment exchanges, universities, libraries, hospitals, departmental stores, banks, stock exchanges etc., he can get quick and effective service in a computerised environment. In developing countries, especially with a public sector bias the common man has been at the receiving end of the bureaucratic manual systems for so long that he will definitely enjoy the services that can be provided in a computerised environment.

In developing countries which have adopted computer technology in a big way, the individual citizen is affected in many other ways also. He can have a computerised alarm in his house to wake him up, a computerised telephone to help him in his telephone calls, a computerised oven which will bake his bread to a pre-determined temperature, a computerised music and television systeOm which will play as per his preferences etc. He can sit and ride a computeised car which will take him to his workplace with very little intervention from him. Perhaps he does a kind of work in his organisation for which he need not necessarily go to the workplace, but can sit at home

and work on a terminal connected to the office. At the bank, in the shops, no money need be exchanged but only computer print-outs after necessary adjustments. Even he need not go out for shopping for it is possible to have computerised ordering from home. He could even hold a computer conference with a businessman in another part of the world sitting at home and avoid a costly and time-consuming travel.

9.8 THE COMPUTER AND THE INDIVIDUAL'S WORK PATTERN

However, inspite of the above rosy picture of man being benefited from computer technology, as an individual he is also harmfully affected in many ways. For one thing the computer is a potential threat to his means of livelihood. This aspect will be dealt with in greater detail later. Another harmful aspect is that to the average white-collar worker, assuming that he is rehabilitated in a computerised environment as, let us say, a data entry operator, the basic question will arise whether he is really relieved of the monotony of his earlier manual work. Is it not only moving from one form of monotonous work to another? In terms of his position and power to influence also it cannot be said that he has gained. In fact in many situations he stands to lose terribly in terms of his power. The typical clerk in a manual system has a lot of power with him in view of his opportunity to harness or help the public at will. He also has considerable influence over his superiors because of his familiarity and knowledge of rules, precedents and procedures, none of which the supervisors are thorough with. If he is rehabilitated as data entry operator he stands to lose terribly in terms of his sway over the public and his superiors.

Of course, the access to computers affects the manager's work pattern in a qualitatively better way. His dependence on others reduces and his accessibility to information increases tremendously. His drudgery reduces and his power arising from possession of relevant and timely information increases.

9.9. THE COMPUTER AND THE INTELLECTUAL CAPABILITIES OF THE INDIVIDUAL

Another highly debatable question which is to be touched upon is whether the dependence on computers for arithmetical operations will affect children in terms of their numerical abilities and there by their I.Q. score. Though no research evidence is available on the subject, it is a fact that many people in the West who work at shop-counters would be completely in difficulty if the computers or cash registers which they are accustomed to fail even for a few minutes.

In our country most elderly people have great veneration for the ability to do arithmetic, mentally and they look down upon children who cannot do such mental arithmetic. The other side of the picture is that many a person who can do quick mental arithmetic can hardly comprehend any higher form of mathematics. Therefore, it can be argued that children who shy away from lengthy and time-consuming calculations may be tempted to take up the challenge of complex problems if they have the support from the computer.

9.10 THE COMPUTER AND EMPLOYMENT OPPORTUNITIES

One of the most hotly debated and sensitive issues arising out of computerisation is its impact on employment. In developing countries, particularly, there is a widespread fear that the computer will

drastically reduce employment potencial or result in retrenchment of currently employed people. The trade unions particularly project this aspect of computerisation especially in relation to white-collar workers such as clerks, accountants etc. On the other hand, the supporters of computers argue that the use of computers, in addition to providing employmen. opportunities in designing, manufacturing, marketing and training, will also raise the demand for services in geometric proportions which will compensate for the fall of employment in routine clerical operations. Another example is that of the printing technology. Another argument brought up in support of computerisation is that most of clerical work is a very low level, repetitive type of human brain work and is a kind of slavery imposed on human beings.

Arguments apart, what cannot be disputed is that the computer has been specifically designed to do things which human beings used to do manually inefficiently. Therefore there is no merit in contending that the computer will not replace human beings in certain jobs. Jobs do disappear with the advent of technology. Mechanisation has eliminated most skilled coremaking and moulding jobs in gray-iron foundries. Computers linked with phototype setters are replacing linotype machines endangering the continued existence of the entire craft. In the insurance industry the introduction of electronic data processing can reduce employment of tabulating machine operators and calculators.

The question that follows is, what weightage should be give to job redundancy in making decisions about computerisation. Should not the added conveniences and better public services be given high weightage? Can some compromises be evolved by invloving the trade unions also in the decision making process?

David B. Archer redefines the problem as below :

> "Our problem is not that computers, automation or technology will create unemployment. Our problem is that the legislation does not exist to adequately look after short run dislocations, and government economic and manpower policies are inadequate to cope with a constantly increasing labour force."

9.11 COMPUTERS AND LIVING STYLES

One of the major changes that can arise is that people need not spend as much time as they spend now in waiting for information. This will release good number of hours for other purposes. Of course this additional time can be used for production or as leisure depending on social interventions planned.

Much better public service at the railway sta' on, airport, banks, hospitals, tourist services etc., can release a lot of tensions and frustrations of the average member of the society in developing countries.

People can reduce a lot of their local as well as long distance travel when the potentialities of both computers and modern communication are combined. This adds to convenience as well as saving of time. Again this time can be used for productive purposes or leisure.

A stage may come when people can trade without having to use notes and coins. This adds to safety and convenience.

Shopping can be done from home. Tickets for a show can be booked through computers. Sale of shares can be done through computers. Books in libraries can be reserved through computers. For the professional who is hard pressed for time these facilities are extremely valuable.

Computer controlled machine operations, chemical processing, control of exposure to various energy beams, rays etc., can provide high accuracy. Hence the society is likely to demand much more accuracy for all products.

The programmed computer robot can do many production operations which are hazardous and which are done by human beings today at great risk. In and around furnaces, in toxic environment, in dizzy heights, in strait and narrow interstices etc., the robot can relieve human beings.

There is perhaps no human activity in which computer cannot have a place, aiding man in reducing his drudgery of repetition of giving him information in a form suitable for taking decisions. In fact the computer can take over decision making in various programmed decision situations.

It can also support him in non-programmed and unstructured situations by helping him to evaluate the possible consequences of several alternative decision choices. When combined with Operations Research techniques the computer serves as a real decision support system. The quality and speed of solving several complex problems, which are being today decided on hunches, can be improved to produce more economy in investments or to generate more acceptability to society etc.

Computerised cars, flights etc., are becoming realities. Such automation can help society to accomplish more speedy and safe travel.

Computers together with modern satellite communication technology has made the world and the countries shrink. The N.I.C. computer link now functioning in our country has linked all the district headquaters and has made the districts and Delhi come very close together for various administrative purposes.

The computers have helped research in a phenomenal way resulting in several benefits to society. The advancements in biomedical area are already available to humanity. Computers also help monitoring of health status of patients in critical condition and have saved many a life.

The list of beneficial impact of computers on society is bound to undergo elongation day by day. Sky is the limit. Imaginative adaptation by the human being of the computer technology is bound to be moving forward in leaps and bounds.

As in the case of nuclear technology, the computer technology is also equally susceptible to be misused either deliberately or unconsciously.

One of the major impacts of the adoption of computer technology is that it will displace a substantial proportion of employed people, especially those employed in white-collar jobs. This will naturally affect society's equilibrium in socio-economic spheres. The trade unions and social leaders naturally will organise people against such displacement. Whether computersation will produce equal or greater employment opportunities in other areas like marketing, manufacturing, servicing, training etc., is a moot question as far as the displaced people are concerned. In a developing country with high unemployment, therefore, the extent of resistance from white-collar workers is bound to be naturally very high. Further in organisations where the number of supervisory positions is fixed on a ratio basis with reference to the number of employees at lower levels, there is a possibility of loss of promotion opportunities. As long as policy level changes in rehabilitation, promotion schemes etc., are not introduced to protect and safeguard the interest of those who are displaced, the resistance will continue.

It is well recognised that the introduction of computers will reduce or eliminate the drudgery of repetitive and low intellectual type of data processing manually. The speed of processing will increase tremendously and this will help quicker public service. However, as far as the nature of work of the rehabilitated workers is concerned, say as data entry opperators etc., they will move into another form of drudgery. Once the initial novelty of the technology wears off the lot of these people is perhaps the same or perhaps worse, since they also lose the power which they used to weild by being in charge of the manual operations. In fact in many bureaucratic systems, the white-collar worker weilds a lot of power through his opportunity to harass the public and inconvenience the superiors.

With the introduction of computer techbology the mix of skills required in the society will undergo a substantial change. This will result in the educational and training scenes undergoing major changes.

Many new opportunities and innovations in these fields will also arise. However in the educational and employment fields which are already in a state of unhealthy competition, more competition will be brought in. The consequence of this will be that there will be more stratification of the society in terms of the extent of computer literacy.

Among managerial people a further division will be created in terms of the extent of computer knowledge and skills. The relatively senior people stand to suffer in this situation, unless they can quickly accomplish the necessary learning. Already the strains of this phenomenon on senior managers is visible.

In the initial stages of the adoption of computer technology there are bound to be mistakes and failures in implementation. There will be a lot of exploitation by manufacturers and marketers. All these will lead to new tensions and problem situatio:... which the society has not faced earlier. Legislative, educational and preventive measures have to be developed and implemented.

The huge potential of the computer technology for handling large volume and complex problems also throws open equally large opportunities to commit frauds. More thinking and innovative safety measures and devices have to be generated.

The time released by the computer may corrupt the society rather than being used for beneficial purposes. This needs careful social interventions.

When more reliance is placed on computers for decision making in such strategic areas like defence, operation of weaponry etc., the magnitude of catastrophies either due to wilful human action or through ignorance also increases. The threat to society is therefore enhanced.

If people can do everything from home more conveniently using the computer, social interactions will undergo tremendous changes. Individuals may become less sociable and more and more self-centred.

The possibility of a moneyless society can take away the pleasures of shopping, bargaining etc.

The threat to privacy of the individual due to storage of enormous amount of data about him in computers is a real social problem to which several countries have started reacting. Many legislations have already been enacted. However, it is doubtful whether legislations can really deal with the problem since the size of the inspecting and prosecuting agencies has to be something like a parallel police force.

From the foregoing discussions it becomes clear that the computer technology is endowed with tremendous potential for benefits to society as well as different types of harmful impact. The question of adoption of the technology or the extent of adoption, the extent and nature of curbs to be introduced, the monitoring and correction process to contain the harmful effects etc., are all matters of social choice which should not be left to the technologist alone. Multidisciplinary groups through democratic procedures should take decisions. The concern which society has for ecological and environmental issues in respect of energy, industrialisation, deforestation, mining, etc., should be extended to computerisation also. It may be that in this process the full potential of computer technology as envisaged by the technologists is not harnessed. But then that is also the safeguard against technological Frankensteins.

9.12 COMPUTERS AND INDIA

Computers were introduced in India in the early sixties. The growth of computer industry in India in the sixties and seventies was slow. However, it picked up gradually and there were 2,00,000 computers in 1990 as compared to 500 in 1979.

Now-a-days in India, computers are widely used across the society from individuals to industry, in both private and public sectors, in the service to the manufacturing sector and for application like fortune-telling to process control.

In 1971, the Electronics Commission and the Department of Electronics were established to further computer usage in a beneficial manner. A computer policy was evolved with the following main features:

_____ Recognition of computers for national security and defence.

_____ Promotion of self-reliance in the computer industry.

_____ Taking care that employment opportunities are not affected by computers.

Earlier, computer policy was protective of Indian manufacturers. Recently, there is a trend to open it up to imports of peripherals and even entire systems. Technological self-reliance, however, continues to remain the corner-stone of India's computer policy and the manufacture of sophisticated computer components like Integrated Circuits is also being taken up indigenously.

Moreover, United Nations Development Programme (U.N.D.P.) helped establish projects in CAD/CAM, and the National Informatics Centre (N.I.C.) which develops computer applications for Government Departments.

9.13 COMPUTER INDUSTRY IN INDIA

India can boast of an indigenous computer industry manufacturing micro and mini-computers, mostly with imported components like chips and peripherals. Some companies are also manufacturing systems in collaboration with foreign companies. In 1989-90, turnover of the hardware sector was 1% of the manufacturing sector at Rs. 6,500 million, indicating the long-distance yet to be covered by the Indian industry.

The software industry's turnover is also mostly composed of exporting low-level software and is in a nascent but fast developing stage.

Ancillary industries for floppies, stationery, ribbons etc, have also come up.

Service industries providing hardware and software support and traning have also sprung up.

Students trained in computers in India are doing well in advanced courses in developed countries like USA also.

9.14 COMPUTERS AND THE INDIAN SOCIETY

Students are the most privileged section of Indian society in terms of computer availability.

Starting from schools to colleges, there is a rapidly growing computer awareness which shall make the future easier for today's students having knowledge of computers, which has become a state-of-the art machine.

The impact of computerisation on employment pattern in India has been positive though employee unions have been hesitant in adopting computers.

Lay-offs in computerised organisations can be prevented by alternative employment like computer operating personnel training for the affected department. Moreover, growth of hardware and software, industry in India has resulted in greater employment generation.

Use of computers in generating data-bases and processing facilities for government departments like Ministries of Transport and Health, Sales Tax Collection (eg.in Uttar Pradesh), employment exchange data (e.g. in Andhra Pradesh), Police Computer Centres, rural development schemes, telephone and electricity billing etc., has grown.

Both service and manufacturing industries are also taking to computerisation and public awareness has grown due to use of computers even for mundane things like displaying scores in cricket mtches" displaying and forecasting election' results on the National TV etc. Several computer magazines are adding to computer awareness in India.

However, in impact of computers on India society has been smaller as compared to developed countries due to high prices, inadequate training and education, cultural factors and poor telecommunication infrastructure.

Still, growing public awareness and the falling personal computer prices in India due to growth in volume, indigenisation and import of peripherals and components at low prices from South-East Asian countries augur well for the In.dian computer climate.

9.15 SUMMARY

This unit discussed the impact of computers on individuals, organisations and society at large. Both harmful and beneficial aspects of computerisation were discussed at these levels.

Lastly, computerisation and its impact specially vvith relation to the Indian context was examined.

9.16. FURTHER READINGS

Archer, David B. 1975. "Computer and Employment" in E. Munford and H. Sackman eds Human Choice and Computer North Holland.

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UNIT 10   COMPUTER VIRUSES

Objectives

After going through this unit, you should be able to :

- define computer virus and its characteristics,
- identify different type of perverse software,
- list the possible damages due to the perverse activities of viruses,
- describe the important precautionary measures to prevent virus infection,
- perform necessary corrective actions in case of virus infection and attack on Personal Computer.

Structure

10.1.   INTRODUCTION

Mr. Vijay Singh, P.A. to Mr. R. Modi was working with his word processor. Suddenly, a ball apeared c his screen and started bouncing from side to side. Mr. Vijay called up the computer manufacturer, wh informed him that he had a virus on his machine. Mr. Vijay retorted, "Oh, God! I am so sorry, yesterd; I had a bad cold. Will my computer be showing the same symptoms after some time? Can you recti this problem or will I have to consult a physisial?"

Such incidents are becoming quite frequent these days. Many of the computers users who are not aw; of Computer Virus are reporting loss of data, programs and several other perverse activities. Are these problems resulting due to Computer Virus? No, the loss of data and programs on computer can; occur due to one or more of the following reasons :

__ accidental or physical damages to hardware resulting in corruption of programs or data ;

__ negligence by employees ;

__ data entry errors ; etc.

But Computer virus is a major cause of data corruption.

Computer virus is a **perverse software** which causes a malicious activity. Computer virus is a relatively new phenomenon which has resulted mainly due to advancement in technology and accessibility of operating systems such as DOS. Previously, the operating system used to be secretive and hidden from the user. A user was supposed to submit his pack of **PUNCHED CARDS** containing a program which in turn was processed by the hardware (and propriety operating system). But with the advent of interactive computers and general purpose operating systems people started working on machines with the idea "How to fail a computer" and hence came the concept of Computer Virus.

The terms like 'Virus', 'Vaccine', 'Stoned', 'C Brain', 'Happy Brithday Joshi', 'Ping-Pong' are becoming increasingly popular. All these terms relate to the same problem, i.e.Computer Virus. In this unit, we will discuss about the features and charactertics of Computer virus, some of the existing virus, their areas of infection, treatment and preventive measures. We will be restricting ourselves to the viruses that are most common on PCs in DOS environment.

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10. 2. WHY PCs UNDER DOS ENVIRONMENT ARE SUSCEPTIBLE TO VIRUS ATTACK?

The popularity of IBM Compatible PCs and its clones have grown tremendously in the last decade. As per one estimate, the number of these PC's, PC-XT's and PC-AT's is likely to be more than a million by 1993. There are certain inherent limitations of the currently used IBM compatibles which most often are being used in MS-DOS environment as stand-alone PCs. These limitations have made PCs vulnerable to security problems. These limitations are :

i) MS-DOS/PC-DOS operating system consists of three files, two out of which are hidden and the third one is named COMMAND.COM (Try to visualise it in the root directory of your DOS floppy or har I disk of your PC-XT or PC-AT). All these files are normally kept in root directory of hard disk or floppy disk. Although the hidden files are not accessible to normal users, yet there exist special commands by which these files can be modified. On the other hand, UNIX operating system, commonly used on PC-386/Super-mini/Mini computers, is installed in a distributed manner in different directories, sub-directories and files. The Operating System files ar not accessible to users and are stored in binary/machine language form, incorporating certain corrective routines. Thus, UNIX is less prone to modifications.

ii) In addition, DOS does not have in-ouilt security/password scheme. Thus, either the user will have to devise his own programs/routines to restrict unauthorised access or will have to use hardware locks and sometimes even physical locks. On the oiner hand, UNIX operating system offers a secured two layer password scheme. One layer is for user-group and another for system administrators (superusers). Thus, each user can have own password. The superuser can add new users or restict/remove users as per the requirements and is generally a trusted person.

10. 3 WHAT IS PERVERSE SOFTWARE?

A simple difinition of perverse software is :

"A software which causes a perverse activity." But, what is a peryerse activity for computer?

The answer to this question lies in the basics of the computer. A personal computer has I/O devices, CPU and Memory and it executes application program/software which in turn do data manipulation. Therefore, a computer essentially maintains, in its storage, the data and the program or software. A program causing hindrances of other program execution in such a way that result in the modification or even complete destruction of data without the user's intentions or unpredictable behaviour in display, print etc. or even sabotaging the operational system are some of the examples of perverse activities for computers. The computer system on which a perverse software is operational said to be an infected system.

But, how does a software cause a perverse activity? The answer to this question is given in this unit in the next few sections, since it requires some more details about computer virus. But we can dwel! for a moment on the reasons for this perverse activity. There are several reasons for it such as : for gaining publicity some individuals have made these type of software ; or are developed by individuals as practial jokes; or as personal vendetta against a company or another person; or may be it is an in-born natural · desire to tease other persons; or an act of a maniac, etc. All these perverse software are aimed towards producing a variety of disastrous effects while normally a user wants to do something constructive with the help of the computer system to increase his productivity and efficiency.

There may be different types of perverse software all of which generate a different type of perverse activity. Yet all these activities have one thing in common, that is, they generate uncertainty for computer users. The normal MS-DOS operations were designed with bona-fied normal users in mind and were not geared up to detect such perverse software. Also, standard security checks normally do not detect the anomaly caused by these perverse software in a computer system. Thus, an infected computer system may continue to work, causing the infection to spread.

The perverse software can be classified in the following types :

a) **Bombs :** Bomb is piece of bad code deliberately planted by an insider or supplier of a Program. A bomb gets triggered by an event which is logical or time based. The bombs explode when the conditions of explosion get fulfilled causing the damage immediately. However, these programs cannot infect other programs. Since these programs do not propagate by infecting other programs, chances of a wide-spread epidemic are relatively slim.

Bombs are generally of the following two types :

i) **Time Bomb :** This name has been borrowed from its physical counterpart because of machanism of activation. A physical time bomb explodes at the time it is set for (unless somebody forces it to explode early), so is the computer time bomb which causes the perverse activity, such as, disruption of computer system, modifications or destructions of stored information etc, on a particular date and time for which it has been developed. It is initiated by the computer clock.

ii) **Logic Bomb :** These perverse software may be similar in perverse activity to time bombs. Logic bombs are activated by certain combination of events. For example, a code like : "If MYFILE is deleted then destroy the memory contents by writing zeros." This code segment, on execution, may cause destruction of the contents of the memory on deleting a file named MYFILE.

These bombs can be set to go off at a future time or event.

b) **Trojan Horse :** This name has been borrowed from the pages of history because Trojans are

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considered to be programs that conceal agents of ruin/malicious activity like the wooden horse of Troy. Typically, a Trojan Horse is an illicit coding contaied in a legitimate program, and causes an illegitimate action. The concept of Trojan is similar to bombs but it does not necessarily get activated by a computer clock or particular circumstances. A Trojan may change or steal the password or may modify records in protected files or may allow illicit users to use the systems. Trojan Horses hide in a host and generally do not damage the host program. Trojans cannot copy themselves to other software in the same or oter systems. The Trojans may get activated only if the illicit progrm is called explicitly. It can be transferred to other system only if the Trojan program is copied by an unsuspecting user.

Christmas card is well known example of Trojan. It was detected on internal E-Mail of IBM system. On typing the word 'Christmas', it will draw the Christmas tree as expected, but in addition, it will send copies of similar output to all other users connected to the network. Because of this message on other terminals, other users cannot save their half finished work.

c) **Worms :** The difference between the Worms and Trojan is that a worm can relocate itself and does not require a host program. Thus, a Worm program copies itself to another machine on the network. The worms are stand-alone programs, and therefore can be detected easily in comparison to Trojans and computer viruses.

Worms can help to sabotage systems yet they can also be used to perform some useful tasks. For example, worms can be used in the installation of a network. A worm can be inserted in a network and we can check for its presence at each node. A node which does not indicate the presence of the worm for quite some time, can be assumed as not connected to the network.

Examples of worms are **Existential Worm**, Alarm Clock worm etc. The Alarm Clock worm places wake-up calles on a list of users. It passes through the network to an outgoing terminal while the sole purpose of existential worm is to remain alive. Existential worm does not cause damage to the system, but only copies itself to several places in a computer network.

d) **Viruses :** The computer virus is a chronological successor of worm programs. The computer virus was termed by Davis and Gantenbein (1987) as : "A Trojan horse program with the capability of auto-relocation (same as in worms) and it can attack other programs." Thus, a computer virus can cause a malicious activity as bombs or Troja.is in addition can do something more. A computer virus is the most dangerous perverse software which can reproduce itself within a computer system. Due to its replicating nature it can attach itself to a regularly used program and make you feel that the host file is benign although it intends to do much more. Computer viruses are highly contagious in nature and may cause considerable damage through an information disorder/destruction. Computer virus can get the better of the operating system which you work on, thereby taking control of the system which may sometimes lead to the destruction of all the data and programs on your hard disk.

Generally, a computer virus acts like a parasite. It draws on the resources of the computer to monitor its activities, but otherwise does not immediatly change the functioning of the boot system. This is done to evade early detection. If the virus has destructive effects, the reaction must be delayed somehow, because if it immediately destroys the host software, it will never be able to reproduce and spread.

Property → Perverse Software Type ↓	Requires a Host	Can Replicate and Relocate
Bomb	YES/NO	NO
Trojan	YES	NO
Worm	NO	YES
Virus	YES	YES

Figure 16.1 : Comparison of various kinds of Perverse Software

10.4. CHARACTERISTICS OF COMPUTER VIRUSES

We have already discussed about the different types of perverse software such as time bom , Trojan horse, worms and virus. In this section, let us first explore, why the first computer vi was developed, and then we will discuss more about computer virus, its areas of infection and reasons of the virus spreading in computer systems.

The first computer virus was designed and tested by Fred Cohen in 1983; on 3rd November. This virus was conceived as an experiment to be presented at a weekly seminar on system security. On 10th November 1983, this virus was first demonstrated, on VAX 11/1750 system. The viru resulted in the crash (failure of the computer system in terms of processing, do not confuse it wit; physical breakdown) of computer in less than 30 minutes. Cohen was so successful that the perinission of continuing his experiments was withdrawn since it was perceived to be a major threat to Computer Secturity. Further tests were banned on the computer virus when it was reported that a user may be granted all system rights by a Computer Virus. The concept of the computer virus was first made public in 1984 at National Computer Secutiry Conference where Cohen published his results. Thus, a major security threat to the computer systems started. The gravity of the threat can be measured from the fact that an "Internet" virus jammed over 6000 military computers across America for almost two days raising a big question mark about the computer security of even the Pentagon computer.

10.4.1. Virus : An Introduction

Computer virus is a software code that can infect otehr computer programs by altering them to include a copy of itself. It is not a boilogical virus. Though non-living and artificially created, the computer virus still has certain analogies to its boilogical counterparts. These are :

- The boilogical virus has specific coded strains while each computer virus has specific signatures.

- Both invade and replicate only in host. The biological virus replicates in human or living organisms, the computer virus replicated in computer programs, thus expanding its inlfuence progressively.

- The patient or host infected by either virus show a set of symptoms or effect. Thus, after detecting the symptoms vaccine for the diagnosed virus can be prepared.

The main characteristics of computer virus are :

i) **Marking replicas :** A virus can copy itself into another place, file or another disk. Typically, if a disk carrying a virus is put into a computer, the virus can get loaded into the machine through Random Access Memory (RAM) and copies itself onto every other disk that is used thereafter. The virus can also propagate a copy of itself through the telephone lines or via network connections. Sometimes a mutated version of the virus may be copied which may be difficult to recognise.

ii) **Autonomous in nature :** A virus may run without being explicitly called by the user of the computer. This is possible because the virus may change the starting up procedure on computer such that the code of the virus is executed prior to execution of the code of operating system. Thus, it has a degree of autonomy.

iii) **Malicious activity :** A virus can cause lot of damage to the computer system in terms of software and data.

_ it may cause loss of data ;

_ it may overwrite some of the important files with unrecognised characters;

_ it may modify programs or software making them unusable;

it may scramble your database or Word Processu. file resulting in incorrect information;

it may not allow the system to start at all;

some special effects on screen like falling of characters or bouncing balls may be produced,

it may display messages graphics on the screen such as Happy Birthday, Give me a Cookie, you: PC is stoned etc.

It is usually believed that viruses cannot damage the hardware. However, there could be situations when it can damage the moving parts. If a virus can produce a sequence of sector Read/Write instruction which can be thrust on one's terminal causing a hard disk motor and IC working for very long duration with a lot of head movement. Similarly, in the case of monitor it may result in rapid changes in frequency oscillations or by creating a high intesity beam (if proper protective hardware had not been used), the beam may destroy the phosphorous coating on the screen. Although no such incidents have been reported, yet one thing is for certain, that is, because of over-working of the hard disk or low level formatting or very high speed rotation for a very long time may reduce the overall life of these hardware components.

iv) **Avoid detection** : A virus may take steps to avoid detection. An active virus is difficult to recognise as it can hide itself from the scanning program through showing a mutated version of itself.

10.4.2 Areas of Infection

Figure 16.2 briefly links the process of starting up with the virus attack.

Power OK	Virus can not be activated.
Read Only Memory (ROM) is Accessed	
Executive Boot Record if DOS floppy is inserted in drive A otherwise execute Master Boot Record containing Partition table of the Hard Disk	The virus which has infected boot record or partition table will now become active - in the memory
Executive the two hidden files of DOS	File viruses which have infected DOS hidden files will be active.
Executive CONFIG.SYS if present Executive COMMAND.COM Executive AUTOEXEC.BAT if present	Viruses hidden in these files will become active. Execution of any infected. COM, .EXE or other file will make the respective virus active in the Memory
Display prompt indicating that now system is ready to accept any DOS command.	

Figure 16.2

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Computer virus normally infect the following areas :

i) **The hard disk partition table :** The partition table of the hard disk consists of information regarding the numbers and type of partition. This occupies the absolute sector on the hard disk and is normally not accessible to an ordinary user. This area is modified by the viruses by including its own code in the partition table information, thus on switching on the system, the virus becomes active. Some of the partition table viruses are : Happy birthday, Joshi, Stoned etc.

ii) **Boot record of hard disk or floppies :** The boot record contains a program which is essential for starting up of computer system as it helps in locating DOS files on the disk. FAT (File Allocation Table) contains the information of what areas on the disk are allocated to which file. Virus changes the boot record by including itself, or a pointer to its code in the disk. This, results in execution of virus code prior to the Disk Operating System files. It may reserve some space in FAT for itself, this space can be marked as bed sector. Partition table and Boot Sector viruses are the most dangerous viruses because : (i) it is difficult to visualise them as the partition table and boot sectors are sensitive areas and normal users are not allowed to handle these areas and (ii) they get activated very early in the starting up procedure, thus, they can take control of the system. These viruses may go unnoticed till the time they strike and by that time irreversible harm to data is already done.

(iii) **Operational files :** Viruses can destory data files yet normally do not infect data files which are non-executable. Thus, a virus can overwrite wrong data on a data file but normally does not copy or attach its code to the data files. User created Word Processor data file, database file, ASCII files, source Program Code files of BASIC, PASCAL are normally not infected by virus. The files which have following extensions often get infected by viruses :

.COM
.EXE
.OVR
.OVL
.SYS
.BIN
or any other files which can be loaded into memory and executed.

10.4.3. Symptoms of Virus Infection

Some of the following symptoms may be observed on the computer if the system is infected by virus :

- Program execution taking longer time
- Any abnormal screen display
- Any abnormal message
- Drive light becomes on unexpectedly
- Decrease in the size of memory checked from CHKDSK or any other memory mapping program
- Increase in the size of an executable file
- Excessive increase in disk accesses
- Delayed disk operations
- Unknown volume label of the disk
- Destruction of data without any reason

10.4.4. How Does Virus Spread?

A virus may get into a stand-alone PC system through an infected floppy used on the system. This infected floppy may contain commercial package or a game package that has been tampered with or may contain virus in its boot sector. In a networked PC, in addition to above, the virus can enter through programs from Bulletin Boards that have been either tampered with or specially designed viruses that are disguised as useful programs.

A user may unknowingly acquire and infected disk, with the system files infected with virus. When a disk of this nature is used to start up the computer, the virus gets activated in the system RAM (Random Access Memory) and reproduces itself to other executable files. Sometimes viruses are intentionally put for some malicious purposes such as spoiling the prestige of a company, or for damaging others data.

10.4.5. The Virus Attack

A Virus can attack a computer in four stages. In the first and second stage, the illicit code may get attached or copied to commonly used system files such as COMMAND.COM or Executable files such as FORMAT.EXE, DISKCOPY.EXE etc. Then a part of the virus code may replace the boot sector partition record by appending itself to these records. This causes the execution of the virus vode prior to operating system (DOS). In an executable file, it changes the normal flow of execution such that the appended virus program is generally executed first and then the required file is executed.

In the third stage of its execution, the virus code checks one or more of the conditions such as :

_ Specific date, time or day

_ Specific job's execution or a combination of keyboards

_ After copying it 'N' times in the system

_ Computer restarting

This delay gives virus ample time for replication before it is noticed.

In the fourth and final stage when one or more of the above conditions are fulfilled, it strikes causing the intended damage. Figure 16.3 summarises the virus attack.
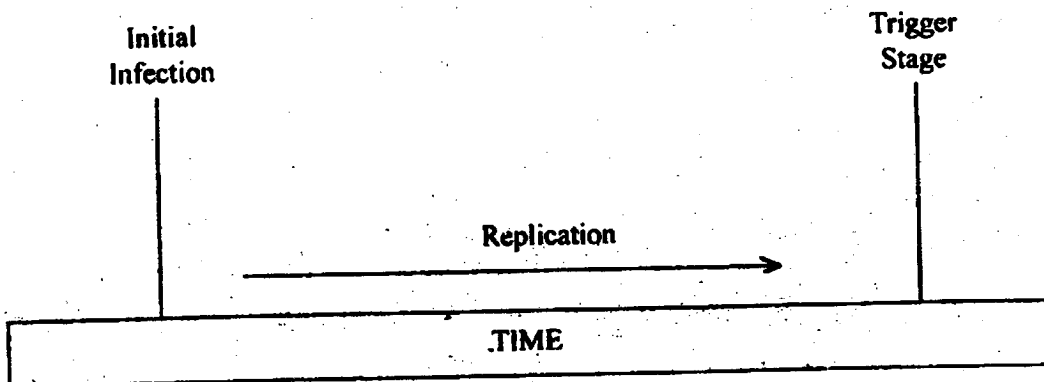
Figure 16.3 : Stages of Viral Infection
(Source : Javeri Harsh and Nanda Suchit : War on Virus (Second Edition);
1991 ; The Computer Bookshop. Page 4)

10.4.6 Names and Features of some of the Popular Viruses

Some of the common viruses which have been detected are given in the following list. People note that the list is not (and can never be) comprehensive or complete but we have tried to give you some of the popular and typical viruses.

i) **Pakistani Brain or C-Brain Virus** : It infects the boot sector of disks and writes "C-Brain" as the label of the disk. This virus gets activated on start up and starts destroying files/data on the disk.

ii) In late 1988, a virus devised by a student Robert Morris jammed more than 6,000 military computers across America for two days. This virus was known as **'Internet'** virus.

iii) **Friday the 13th virus** is a time bomb virus. This virus gets attached to .EXE or .COM files On any Friday which falls on the 13th of the month it removes the infected file from the disk The affected computers can be slowed down. The virus, was widely distributed prior to its detection.

iv) **Israeli Virus** : This virus was first reported by an Israeli daily newspaper in January 1981 and hence the name. The virus starts destroying the files on May 13. It slows down the response of computer on the thirteenth of every month It was detected due to the wrong code of the virus itself. During infection phase, it was infecting the already infected executable files, thus, increasing the size of the original file to a great extent which caused its detection

v) **Lehigh Virus** : It was first detected in November 1987. It gets attached to COMMAND.COM file and destroys the file after four replications.

vi) **Bouncing Ball** : A benign virus, presumably intended to do nothing more than amusement. While working on the computer you will find a bouncing ball appearing on the screen. It may not damage any file.

vii) **Happy Birthday Joshi** : This infects the partition table or boot sector and prints prompt "HAPPY BIRTHDAY" on the screen when it strikes. This may cause lot of damage to data files. Sometimes it may not allow even starting up of the computer.

viii) **Stoned** : This is also a partition table or boot sector virus and on striking it produces a message "Your PC is stoned". This also causes damage to data files, and may not allow the system to be started sometimes.

ix) **Dir-2 Virus** : These days it is very much in the spread at Bangalore. It is a boot sector virus and is difficult to recognise.

x) **Raindrop Cascade or Gravity Virus** : This virus normally resides in .COM files. If the infected file is run and certain system conditions are satisfied (logic bomb virus) then its effect will be manifested in the showering of characters and letters on the screen.

10.5 PROTECTION AND TREATMENT

In the preceding sections, we have discussed the various characteristics of computer virus. By now, we are fully aware of its dangers and harms. Therefore, we must do something to prevent virus infections from occurring. In this section we will describe the preventive methods for virus attack and to rectify a system if virus has been detected. We can perceive four major activities in this respect.

i) Preventive measures
ii) Detection of a virus
iii) Removal of a virus
iv) Recovery of the damaged data files

10.5.1 Preventive Measures

"Prevention is better than cure." We must observe the following precautions while working with computers :

i) Never use an illegitimate or pirated copies of software. Don't accept free software from unknown persons. Buy software only from legitimate source. Accept the software which is either shrink wrapped or securely contained or sealed. Make a back-up copy of purchased acquired software, store it at different location, and check even these software for virus on a stand-alone PC. While checking the software/program, take the note of the programs execution. Check that it is consistent with the objective of the software. If you have more than one PC's then, preferably keep one as a stand-alone PC for checking the software. You can name it as virus detection machine.

ii) Use of reliable memory resident programs or hardware virus protection card which do not allow virus to enter the system is strongly recommended.

iii) All the disks should be write protected. This write protection should be removed only if something is to be written on the disk.

iv) Provide physical security for your computers i.e. Locked rooms, locks on the computers etc. Log-out while leaving terminal/system. This will help in avoiding unwarraned people to come with their floppies which may infect your system.

v) Do not use external floppy disks. If you are ensure of a floppy disk or a specific program, run it in an isolated environment where it will not be able to do any damage.

vi) Do not swap floppies across machines.

vii) Start a machine with an uninfected, write protected disk operating system.

viii) Check floppies and hard disk periodically and remove infected programs immediately.

ix) Establish a sound Back-up policy. Make sure that you have at least three sets of back-up disks which you can rotate through a regular cycle of use.

x) Prevent access to unauthorised users.

xi) Make all the programmers/users aware of the security procedures and carry out surprise/ regular checks.

xii) Maintain registers for having a strict control on software, data and program acquisition.

10.5.2. Virus Detection

The various symptoms of virus attack has already been discussed in sub-section 16.4.3. if you follow the strategies discussed in 16.5.1 probably your computer will never be infected. Yet it is better to check the computer at least once in a week to avoid sudden data loss. Some of the common scanning programs available in the market can be used for checking. The best way to check is by inspecting the size of COMMAND.COM, using programs that show the partition table of hard disk and boot record and the programs that map memory usage. Most of the times by only visualising the boot sector or partition table you can predict the presence or absence of partition table and boot sector virus. Since it leaves some readable marks such as HAPPY BIRTHDAY, JOSHI or YOUR PC IS STONED or signatures of specific virus on to your system. Various virus detecting software are now available in the market for checking the kind of virus infestation.

10.5.3. Virus Removal

Once a virus has been detected, it is necessary to remove it before it causes further damage. There are a number of software available in the market. We will not be giving details about these products. Let us give you certain general methods which may be required by you if you do not have a proper vaccine program.

a)   Writing another useful (as opposed to perverse) virus program that finds the signature of harmful viruses and overwrites these sectors. For example this virus may replace anything in the boot record by an original boot record.

b)   Using anti-virus software available in market. Some of these anti-virus software can be made memory resident and can be put in "AUTOEXEC.BAT" or "CONFIG.SYS" such that they become functional soon after the computer is started. These memory resident programs try to detect the presence of offending code. In case the presence of offending code is detected the computer is halted and a warning message is flashed on the screen. Afterwards the same software may be used to eliminate the detected virus from the computer. Also, certain watch dog or scan programs are available in the market. These programs regularly scan RAM and hard-disk for the presence of viruses. You must be cautious of bogus anti-viral programs that are actually viruses in disguise.

The anti-viral software still lags behind virus development. Therefore, these software may not succeed. These days certain anti-virus hardware cards are also available in the market.

c)   Start the infected system from 'A' drive by an uninfected floppy. Attempt to over-write the Boot sector of the hard disk or recreate partition table using special programs. This procedure is successful in some cases. Although the virus code may still physically exist on the disk but it cannot be run since the loading program has been deleted.

d)   Another more rigorous procedure is to search the entire disk, sector by sector, until the virus program segment is located. Then erase the infected program segment. One of the common techniques which is less taxing than above is to search only those sectors marked as bad by FAT (File Allocation Table) and then remove these bad sectors.

e)   Executable Files Infection can be removed but they do not guarantee restoration of normal executable files. Thus the best thing to do with an infected file is to delete that file and load the new program.

f)   The ultimate method of removing any virus is **Low Level Formatting** but it wipes out all the software and data of your system. Start the system from A drive using an uninfected floppy. Take the Back-up of all the files and data from hard-disk to floppy disks. Now perform low-level formatting with the help of standard software or debug command. (For debug command, kindly refer to your system manual or service engineer) And then, reload the data only after testing it thoroughly for virus on an isolated PC. The low-level formatting should preferably be done in the presence of a system engineer.

10.5.4. Recovery of Damaged Files

The damaged files can be of two types :

●   The executable file which is infected by the virus may not be recovered even after removal of virus code. There fore, the ideal thing to do is to keep a back-up of all the software, and store it at different locations. When an executable program is damaged by an infection of virus, delete this file and then restore the files from the back-up.

●   A data file whose data is corrupted completely cannot be recovered.

- Although the data base files may not be corrupted completely, yet they are difficult to recover as scrambling of data may have taken place.

- A long word processor file: if not corrupted fully can be partially recovered using some advanced software.

10.6. SUMMARY

In this unit we have discussed a major problem faced by micro-computer users today, i.e. the problem of Computer Virus. We have also discussed about the different types of perverse software such as time bombs, logic bombs, Trojan horses, worms and viruses. In addition we have discussed about virus infection. Here we would like to recapitulate that basically viruses infect files or certain areas of the disk, or ever-both of them. If a virus wants to spread via executable programs (EXE or COM files), it must attach some extra code onto that program. The viral code may be added to the file or it may replace some existing code. For such a virus to become active, the infected program necessarily has to be executed. For viruses which infect the critical areas of the disk, the computer has to be booted from th infected disk. Thus, only if you run an infected file or boot from an infected disk, can viruses get into the system.

The intention in the unit is to make you aware about dangers of computer virus so that you can chalk out you priorities to fight against its menace. This problem can be prevented/tackled, by proper safety measures.

The number of computer viruses is growing tremendously. Although in some countries there is law prohibiting making of harmful viruses, still there is no legal action against a benign virus developer. The legal issues involved are quite complicated and very new to this country.

Currently lot of hardware/software solutions are being proposed for the Computer Viruses, yet their effectiveness has not been tested or reported. The number of viruses and vaccines are increasing day by day. If you are interested to know more about latest viruses and vaccines then kindly consult latest security journals.

10.7 SELF - ASSESSMENT QUESTIONS

1) Differentiate among Trojans, Worms and Viruses. Give one example for each.

2) "Computer virus is a major threat to computer security." Justify the statement.

3) Assuming that you are managing the computer center which have stand-alone PC's what rules you will frame for users.

4) Why should there be law against benign computer virus maker? What harm can it cause to your computer?

10.8 FURTHER READINGS

Simons, Geoff 1989. *Viruses, Bugs and Star Wars - The Hazards of Unsafe Computing*, NCC Blackwell, Oxford, England.

Understanding Computers-Computer Security by the editors of Time Life books, Time Life Books, Alexandria, Virginia.

Javeri, H, and Nanda S., *War On Virus*, The Computer Bookshop, Second Edition.

Suggested Journals : *Compters & Security* (U.K.), *Computer Today*, (Indian), *Data Quest* (Indian), *PC Quest* (Indian), *Computers & Communications* (C&C), *Science Reporter* (October 1990).

UNIT 11 LEGAL DIMENSIONS OF COMPUTERISATION

Objectives

"he objectives of this unit are :

to bring to focus the types of computer-law interfaces :

- to explain how a computer purchase/sale is a contract.
- to present a brief discussion on how a user can legally protect his programs and data,
- to discuss situations where liability arises with regard to computers even though there is no contract,
- to bring out the right to privacy and confidentiality for individuals.

Structure

11.1. Computers and law

11.2. Purchase or Sale of Computers

11.3. Legal Aspects of Use of Computers

11.4. Tortious Liabilities in Use of Computers

11.5. Privacy and Confidential Information

11.6. Summary

11.7. Further Readings

11.1. COMPUTERS AND LAW

The occasions when a computer user can benefit by knowledge of law applicable to the field of Computer and its applicatins abound. To mention a few :

__ When you are buying or selling a computer, both hardware as well as software and also pe ripheral systems

__ When you are using a Computer

__ When you are trying to change over from manual to a computerised system or when you are trying to upgrade your existing computer system

__ When you incur loss or damage as a result of the use of computer by others

__ When you cause harm to others by your using computer

__ When you want to do programs and patent them or secure copyright

__ When you want to keep some parts of your technology of hardware or some aspects of your software confidential

__ When systems connected to or operated through computers go faulty and you suffer as a result of such faults

__ When your privacy is affected by storage of information relating to you in computer

__ When malpractices are committed in computer and you suffer damages as a result of such malpractiees

__ When you engage the services of a consultant or firm to provide you information services

__ When your health is affected by the use of computer.

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Each country attempts to deal with computer related legal matrters within the framework of the existing laws by reinterpreting the legal provisions. In a few cases some countries found it necessary to amend, add or modify existing laws suitably to deal with special situations arising from computer related matters. These aspects will be discussed in subsequent units.

Activity A

If you or the organisation in which you work has purchased a compouter, recall and write down how you drew up a specification. Any time after purchase, did you feel that you did not have a fair deal in respect of some aspects of hardware or software?

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Activity B

Write down from your experience or from your imagination the different ways in which a computer in an organistion can be misused.

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11.2 PURCHASE OR SALE OF COMPUTERS

Introduction

Computer technology being relatively new to developing countries like India, the consumer is rarely aware of even the fundamentals of computers. Also consumerism is still very weak in developing countries. As a result the sellers dump their products on the consumer. The customer often buys computer as children buy toys. Most consumers buy without kowing what they actually want to do with the cornputer or whether the computer with they are buying will really suit their specific requirements. The situation is true bnoth of individuals and organisations. In many cases the computers remain merely as show pieces after purchase and are often used for playing games.

Purchase/Sale - A Contract

Every purchase of any movable article is a contract covered by the provisions of a branch of contract law known as sale of goods. In our country sale of goods is governed by the provisons of the Sale of Goods Act 1897.

Off - the - shelf purchase

Sale or purchase of goods can be broadly of two types, one in which a specific product with specified features is offered by a seller. Here the seller fully discloses all the features of the merchandise to the buyer through literature in the form of pamphlets, manuals etc. The buyer may buy with or without inspection relying upon the specifications disclosed. Here the buyer buys a product with full knowledge of what it can accomplish, provided the equipment works according to the features offered. In such a deal the buyer cannot complain later that the equipment he purchased did not fulfil his requirements. The purchase is similar to any other purchase of consumer articles which ar purchased from shops, say for example a branded packet of cornflakes. The buyer has a cause for action only if the flakes are found to be not cornflakes or that it is spoiled etc. The customer cannot say that the children did not like the taste of cornflakes and that therefore the purchase price should be refunded.

Similarly when a sustomer buys a computer of a branded variety of say, a P.C. by brand name, all that he can demand later is that it should have capabilities and features described in the pamphelts or manuals. If due to the volume of data to be handled or the high speed required for his specific purposes, he finds the P.C. unsuited to fulfil his requirements he cannot raise a claim against the sellter.

Purchase based on Buyer's Specifications

Let us now take second kind of purchase inwhich the buyer specifies his actual requirements and relies upon the seller to give him an equipment that will meet his actual requirments. In such cases the buyer can, if the equipment fails to suit his purpose proceed against the seller and claim a replacement or damages. Suppose a buyer explained to a seller that he wanted a grinder to grind wet cereals and reiied upon the seller to choose an equipment and later found that the grinder which he was sold will only grind dry, then he can compel the seller to give him a replacement that will grind wet or if this is not possible claim damages or refund.

Let us now take an example of this latter situation on to the computer field. Suppose a professional stock broker specified that he wanted a computer which can store and process transactions of a large number of his clients say fifty thousand customers a day and also that it will be necessary to process the transactions of all the customers as one batch and the seller sold him a P.C. with one floppy drive only and main memory of 128 K.B. We can imagine what will happen later. Since the buyer had specified, his requirements clearly and also had depended upon the seller to sell him a suitable computer, he has a cause for action against the seller. On the other hand, if he had listened to a sales talk or seen an illustrative demonstration and then chosen the P.C. in question on his own judgment, he cannot raise any claim later against the seller.

The above principle of buying is so fundamental to all types of buying of movable properties and therefore it would benefit both buyers and sellers equally to be aware of and adhere to it. The principle binds individuals as well as organisations. If the buyer is clear of what he wants and he buys on a specification based on his needs and the seller sells an equipment supposedly to meet the buyer's needs, then the buyer is on strong grounds. It would thefore be in the interes of the buyer of a computer to spend some time on why and for what specific requirements he wants a computer. The situation is all the more applicable to organisatins since organisations usually make larger investments. Ofcourse in the current scene of little or no awareness of the technological aspects of hardwaie and software, it might be necessary for the buyer to seek help from a consultant. With or without the help of a consultant a reasonably good systems analysis has to be done before investment. Also the hardware and software requirements have to be translated into specifications for purchase. When both these steps do not take place the buyer will have to be satisfied with shelf products.

A word of caution regarding specifying the speed of the hardware. Many users mistake the speed of computer which they see in some demonstrations as the speed at which they will get results. When volume of data is large as in most Dbase applciations in real life, time involved in processing is greater. It would not be practicable to include in specifications that the hardware should be capable of completing the processing of a certain large number of transactions say, of accounting shall be computed within a given time, because time required to process is dependent on the kind of sofware used also. Further, when an individual or organisation has its own computer system it may be more economical to use the capcacity fully and hence it may not be worthwhile to invest much in fancy speeds.

This brings us to another aspect of computer buying, where the buyer is in a dilemma as to what capacity of computer should be specified-whether to specify a capacity to suit current needs or future needs. There are some options here. A buyer can invest just enough to meet current needs and forget about future. After all one may argue that the technological changes taking place are so fast that there is not much merit in buying current technology with reserve capacity for future at large investment, since under the fast changing technology, larger capacity units may even be cheaper and more powerful in the future. Another option is that upgradability be made part of the specifications and the seller bound by contract to provide upgradations as and when the buyer chooses to have. The main point which has legal implications is that upgradability has to be specifically made a conditon of purchase, failing which the buyer cannot have a later remedy for outdation. This aspect has much significance in the current market conditions since competitive edge in prices is achieved by many a manufacturer by providing absolutely minimum capabilities, that too with no features supporting upgradation.

Compatibility with Peripherals etc.

Compatibility with peripherals like printers, communication equipment like fax, telex etc, also are better specified in advance, so that if the buyer wants to link the computer with such facilities later, he may not end up with problems. In situations where the buyer is already having one system and he is trying to upgrade it or expand it, the compatibility aspect will be all the more important. It is generally calimed that hard disks can be added to an ordinary P.C. quite easily, but when it comes to actual application many suppliers try to wriggle out of this type of upgrading.

After Sales Service

Still another area where the buyer is advised to specify clearly is the after sales service facilities. Computer is after all a piece of equipment and would need frequent servicing. In the current Indian scene third party maintenance is yet to pick up and therefore after sales service in the form of annual maintenance contracts or other type of periodical maintenance on actual cost basis etc. have to be specified by the buyer.

Compatibility with Software

Compatibility with software as also the purchase of software are two aspects which deserve much attention and specification by the buyer. The usual sales talk as well as computer advertisements try to lure buyers to invest on hardware as if software is something which is automaticlly available with hardware (of course this would never be specifically mentioned). The demostrations of the product are also usually so organised that the unknowing buyer is led to believe that once he buys the hardware he has only to take it home and hook on to the plug for getting his outputs. It is only after investing on the hardware that the unknowing buyer is told that for operating the computer software is to be purchased separately. This aspect of software purchase will be dealt with separately.

Networking

Still another aspect of hardware purchasing deals with incorporation of specifications for networking of computers. Not all makes and all types of computers can be networked. Further both additonal hardware and software are required to do networking. If the buyer hopes to do networking later then he should specify at the time of purchase of the computer system that he wants a model which will enable networking at a later date.

Inspection before Purchase

It is one of the basic principles of the law of sale of goods that when a buyer has purchased after inspection of a sample, the goods delivered should conform to the sample, failing which the buyer can proceed against the seller. However, this is a double-edged sword for the seller may also try to take advantage of the position that he is bound to provide only such features as were incorporated in the sample. When inspection of the sample is not thorough the buyer will suffer. Again there may be several features of a product which cannot be revealed during inspection. The buyer has therefore to be clear of what aspects he wants to understand by samples and what aspects by actual use subsequent to installation.

Conditions, Guarantees and Warranties

This brings us to the question of the liabilities of the seller for conditions, guarantees and warranties and training of operators and installation and commissioning. Conditions of sale, payment conditions etc. are so vital to the contract of sale that non-fulfilment of such conditions may even render the whole sale void ab initio. If for example delivery is to be made within a certain period after the payment of say 25% of the total price then unless and until the payment is received and the specified period is over the seller is not bound to deliver. In leasing and hire purchase schemes etc. the ownership of the equipment (referred to as property in goods) passes on to the buyer only when the final instalment is paid. Until such time he has only physical possession. If payment is not made according to terms or payment is delayed the seller can take away the equipment. Guarantees and Warranties on the other hand have different consequences. When a computer such as say a P.C. is guaranteed for performance for one year (may be subject to certain conditions such as that in case of a problem the supplier or his authorised agent only shall attend to repairs etc.) then if the equipments fails within the guarantee period the supplier is bound to make it work at his cost either by repairs or replacement. Warranties, on the other hand relate to the features of the equipment which are not so vital to the performance of the equipment. Hence they do not attract the same consequences. The seller can choose to repair the shortfalls or agree to pay damages. For example if the sample P.C. inspected by the buyer had a particular manufacturer's V.D.U. and the finally delivered computer had a V.D.U. manufactured by another company the seller may argue that both V.D.U.s provide the same performance. The buyer can, if he proves that the supplier has saved in cost by using the latter V.D.U., claim a reduction in price. Of course, there is no end to such debates and a prudent buyer will confine his attention to major vital components of the computer.

One more fundamental principle of sale of goods is that a seller professing to sell a particular equipment which is commonly known to perform certain essential functions must make available an equipment which will perform substantially such functions irrespective of guarantee clauses and warrntly clauses. This a seller who sells a car with or without guarantee conditions has to make available to the buyer a minimum of what a car will do. Therefore a seller of car cannot take shelter under the absence of guarantee clause to sell four wheels and a body without engine. Therefore if an ignorant buyer buys a "Computer", then he can always compel the supplier to provide him with an equipment that will perform the essentials of what a computer will do. However,

considering the sophistication and advancements that have come up in the field of computers there can be never-ending disputes on what a "Computer" should essentially possess. Only a court of law, after protracted examination of evidence can decide such issues. The more prudent step for a buyer is to eliminate disputes as far as possible by becoming clear of what he wants and then bargain for the purchase of what he wants.

Purchase/Sale of Software

Software is the brain of the computer. Without the relevant software even the most powerful computer cannot accomplish anything.

Considering the fact the software is as costly or even more costly than hardware the buyer has to be quite alert and vigilant about the conditions of procurement, compatibility with hardware, usability for specific purposes of the buyer etc. As already mentioned the manufacturers and suppliers of computers project hardware in such a way that the ordinary citizen does not realise that software is not included in the bargain. There is only one exception to this, namely the computer sales by the E.T. & T., who include in their sale price the cost of essential software for using the computer.

There are two types of software, the system software and the application software. Without the system software such as the Disk Operating System or the Unix or other types the user cannot proceed to use the computer at all. Even many a reputed manufacturer/supplier keeps the price of operating system extra and project the price of the hardware low. During demonstrations the suppliers demonstrate the capabilities of the computer using several sophisticated application softwares and the ignorant buyer may believe that all those are part of the hardware.

To take an example, suppose a P.C./XT costs Rs. 30,000. A professional like a chartered accountant would need to invest about Rs. 2,000 in M.S. DOS, Rs. 20,000 in Dbase, about Rs. 15,000 in lotus and about Rs. 7,500 in a wordstar for using the computer for his various needs. The cost of an 80-column printer would be about Rs. 10,000. The other alternative for the chartered accountant would be to go in for an M.S.DOS and then specific application packages for financial accounting and a wordstar which costs about Rs. 17,500. But then the computer can be used only for the limited purposes which the financial accounting package and the wordstar will facilitate. It would therefore be in the interest of the buyer to specify what kind of software he wants while negotiating the purchase of hardware.

Another form of software purchase is when the buyer contracts with the supplier of the equipment to provide tailor-made software for the specific needs of the buyer. This is the usual practice in the case of organisations. The supplier has then to do systems analysis and develop application programs to suit the needs of the buyer. In some cases it may be that the customer has some software and he needs a system which will enable him to use the software. This often happens with professionals who go abroad and bring software which they find attractive. Another situation may be one in which the buyer has both a system and software, but then he wants to expand and network the system for larger use. In all such cases the buyer and supplier have to sit together and understand the ambit of supply, negotiate, lay down the responsiblities of the supplier and draw up a proper contract. It is needless to point out that in all such situations the sale of goods is not a mere off-the-shelf sale. There are many instances in which, for want of proper understanding regarding the scope of work and the extent of responsibility of the supplier, the suppliers have walked away after dumping costly hardware on the buyer and the buyer keeping the equipment a a mere showpiece.

Computer Services

There are also situations where computer services are obtained by individuals or organisations through agencies which provide such services. Here the taker of the services is not bothered about hardware or software, but is paying for only a specific service. While there are many advantages for the taker of such services, there are also disadvantages such as the loss of privacy, high service cost, too much dependence on an outside agency etc. There is practically no sale of goods in such cases and the transactions are governed by the terms of the service contract.

Case Law on Computer Hardware and Software Contracts

Lovable Corp. V. Honeywell Inc. 431 F. 2 668 (CAS, 1970) is a case which covers both hardware and software aspects. (1)

In this case regarding the scope of equipment to perform and give results, District Judge Edenfield said in his dissent at p.677 'The contention of Honeywell, adopted by the majority, is that it was to do little more than to furnish certain naked pieces of equipment. It did imply that the machine would run, since it was to furnish maintenan e, but its contention is that it did not promise that it would accomplish any results whatsoever or even print a single line. Like the Mona Lisa of the ballad, its computer, as far as guaranteed resu s were concerned, was just cold and lovely work of art. I simply cannot conceive of two capabl businessmen negotiating for the sale or lease of a computer except on the basis of what it wou ld do.' (While in this case the judgement is not in favour of the buyer under the peculiar circum ances of the case, the case is quoted only to point out that the dissenting judge's position is also available to buyers in appropriate situations.)

In Honeywell Inc. 1C.L.S.R.810(1971) where the supplier was also to supply system software for specified purposes, provision by manufacturer of such software was regarded so fundamental that it was made a prerequisite of the contract , and failure to develope such program was held to invalidate all claims for payment under the contract even though the machine was otherwise installed satisfactorily , and indeed used by the customer as a stand - alone device .(2)

The same considerations apply to acquisition of software as apply to the acceptence of hard ware. In particular, as already mentioned the buyer sh uld specify in detail what operating system is to be supplied , the types of peripheral devices to e accomodated , and the programming languages to be supported. This latter requirement may t e vital when negotiations are being conducted , especially where the buyer already has a set of programs which he wishes to run on the new equipment . In one case it took a highly experienced software house over three months to convert a legal information retrieval package running quite happily on an IBM 1410 to an RCA spectra 70/45 . (McDonnell Automation Co. 49 comp, Gen. 124 (1969)) (3)

in another case (Xerox Corporation 5 C.L.S.R.734 (1974)) the buyer had some 450 programs to run , but the prospective contractor was only willing to convert 117 of them , apparently on the basis that this was the equivalent to the 200 hours of computer time and six months of on-site programming and file conversion specified in the request for proposals (4)

It is equally important that where the customer needs to achieve compatibility with a reserve or back-up computer or if he intends to expand the capacity of this system in future he should specify this. In Manufacturing Data System Inc. 5 C.L.S.R. 723 (1974) both of these factors were present in the requirements of the army for a numerical control system for installation in an arsenal . The system had to be as compatible as possible in its programming language with a much larger computer which was intended for back -up purposes, and it must be capable of being upgraded to handle direct numerical control. Here although twenty different languages could accomplish the immediate task ,only one met the compatibility requirements . (5)

Activity C

Study the contract for the supply of fairly large systems of computer and peripherals and the software and discuss how far the matters dealt with in this unit apply to the transaction.

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11.3 LEGAL ASPECTS OF USE OF COMPUTERS

Introduction

Apart from the contractual obligations arising from the sale/purshase of computers and software, there are many other legal consequences that follow when a user uses a computer. Some of the more important aspects of these such as patents, copyright, protection of trade secrets etc. will be discussed here.

Patents

As has already been discussed, a hardware alone is useless without software. If the user has programming capabilities he can develop his own software using any language like Basic, Cobol or C etc. Alternatively he may use Dbase, Lotus, Unify, Ingress or other general purpose packages to develop suitable application software. Without taking the trouble to do either of the above, he can buy readymade execution programs for specific purposes. He can also engage consultants to develop specific software from languages or general purpose software. Somebody has to develop programs. Suppose a user or consultant makes a program which he thinks is original in its own way can he legally protect it as his own creation by becoming the owner of it in a certain sense? If this were possible, then when other want to use it they can be made liable to pay certain charges on agreed basis. The law on 'patents' deals with such situations. Each country has its own legislation on patents, Here the software created is treated as something similar to an invention in, lay, engineering or a new soft-drink recipe etc. Patenting involves certain procedures. The aopplicant has to make full disclosure of what he has developed. The patenting authority should get convinced that it is not a mere reproduction of something already patented. Again the field of patents and law connnected with it are riddled with lots of debates and disputes. Mere intellectual advancements to knowledge such as say a theorem in mathematics etc. cannot be patented, since if that were the situation free and unfettered advancement of knowledge would be inhibited. It would appear that patenting would be possible only when the object patented is capable of being utilised by others for the purpose of commercial applications. Ordinary computer programs cannot be patented.

In UK the Patents Act 1977 applies. In USA the Patent Act 35 U.S.C. applies. In India The Patents and Designs Act 1914 applies.

In Burroughs Corporation (Perkins') Application the claim was for a method of transmitting data between a central computer and remote terminals. The superintending examiner disallowed the claim relying on the then prevailing decision in Slee and Harris's application that claims for simple processing of information are barred. The Patent Appeal Tribunal overruled the decision in Slee and Harris's application and held that "in our view programs which have the effect of controlling computers to operate in a particular way, where such programs are embodied in physical form are proper subject matters for letters patent". (1)

In 1977 in UK the Patents Act excluded 'a program for a computer' from the scope of inventions. However it was also provided that the foregoing provision should prevent anything from being treated as an invention only to the extent that a patent or application for a patent related to that thing as such.

Copyright

Copyright is another form of legal protection which software people can resort to for protection of their products. Copyrights can be claimed for data as well as programs. The former is concerned with the use of information which is copyrighted and stored in retrieval systems. The latter relates to protection of programs which are marketed to the general public using computers.

There remains a number of problems in deciding how far the law on copyrights relating tc intellectual property can be applied to computer programs. In England the Copyright Act of 1956, although written in the computer age, does not reveal the realisation of that fact. It would appear that programs are protected as literary works within the meaning of section 2 (1) of the Act. 'Literary work' as per that Act 'includes any written table or compilation' and 'writing' including any form of notation, whether by hand or by printing, typewriting or similar process. It might be reasonable to interpret 'written' in the definition of 'writing' and in that case computer progrmmes may qualify whether printed in the conventional way, punched on card or paper tape, or magnetised tape or disc. On the other hand it has been argued that nothing in the Act prevents the unauthorised use of a program by running it on a computer. The Whitford Committee (UK) is in favour of the former view, but has recommended confirmation by legislative enactment.

The position in USA is more clear after the enactment of the new Copyright Law in 1976. Hundreds of programs have been accepted for copyrighting since then. The basic protection afforded by copyright is directed against reproduction of the form of the original material. If material such as rules of a game can be used without copying, then copyright is not infringed. To obtain copyright protection it is necessary to obtain registration and also affix copyright notice to a computer program. In order to preserve copyright protection it is essential that there is no unauthorised publication of a program by purchasers or licencees without explicit reservation of the copyright

Trade Secrets and Confidentiality

Another method by which a person can protect his computer programs is by relying on common law relating to trade secrets and confidentiality. There is no doubt that computer programs are eligible for this form of protection, so long as they have progressed beyond the stage of general idea to approach some specific problem. (Electronic Data Systems Corp. v. Kinder 360.f. Supp. 1044 (N.D. Tex., 1973>(2)). Indeed associated documentation such as user's manual or a flow chart would also be eligible for protection. In fact this branch of law probably supplies the most widely adopted form of protection for computer programs as of now. This is especially so in the case of programs which are written in-house for use by a firm upon its own machine. Here the programs need never be divulged to anyone outside the firm, and employees can be restrained by contractual provision from making the programs available to third parties either during their service to the company or even after its termination, at least within reasonable limits. Contractual provision may be similarly prayed in aid of the secrecy of programs which are divulged to third parties by way of sale, lease or license. Detection of abuse, identification of offenders, and certainty of remedy are all enhanced by comparison with patent and copyright protection.

In Seager v. Copydex Ltd. the basis for calculation of damages was to assess the value of the information to the defendant. If it lacked the inventive qualities necessary to qualify it for protection as a secret, but was nonetheless useful to the defendant in developing its product, it was felt that the cost of obtaining comparable help from a consultant should be adopted as the measure of damages. (1967. 2 All E.R. 415). (3) (1), (2), (3).

Activity D

Look at the first few screens of software like Dbase, Lotus etc. and note down the notices of copyright and protection of trade secrets.

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Activity E

Visit a fairly big Computer centre and note down the contents of written notices which they have used warning against removal from the centre of programs and data.

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11.4 TORTIOUS LIABILITIES IN USE OF COMPUTERS

Introduction

A tortious liability arises when one suffers loss because of the action of another (such as say, use f computer) even though there is no contractual relations between two persons. The computer is not, by and large, a physically dangerous machine. It does pose some electrical and fire hazards, and peripheral equipment has some moving parts. Occasional cases of physical injury may arise, but are rare and legally uninteresting. This really leaves only three basic categories, cases of fraud or deceit, cases of negligence and cases of breach of statutory duty. There may of course, be other remedies than tortious claims also in such cases such as criminal liabilities and contractual liabilities for warranties etc. One of the most common situations in negligence is that of the computer salesman who makes a careless claim in an attempt to sell a system.

Cases on Torts

Cases directly bearing on computer related torts are rare. So we have to rely on case law relating to use of modern technology other than computers per se. In the famous British case of The Lady Gwendolen, the master of a ship laden with cargo sailed at full speed from Dublin to Liverpool despite the onset of dense fog at the mouth of River Mersey. The ship was fitted with radar, but the master looked at the screen only occasionally, for most of the time it was set to the wrong range and was generally found to have been used very negligently. On account of such negligence the court refused to limit the liability of the owners under the Merchant Shipping Act 1894.

Another case bearing on tortious liability relating to use of modern technology (or the absence of it) is the British case Broad Street Bank v. National Bank of Goldsboro (112 S.E. 11 (n.C., 1922)). At the time of the case the state of the art was that cheques written on standard paper in ordinary ink could be erased invisibly and altered to show larger amounts than those for which they had originally been drawn. The president of the defendant Bank had failed to use any of the special

papers and cheque writing devices which had been developed by modern technology at that time. The plaintiff lost large sums of money. It was held that even though it was common practice, even of the defendant to use such devices it could not be regarded as negligent to fail to do so. This case only shows that failure to adopt a modern technology would not be a negligent omission.

In Port City State Bank v. American National Bank (486 F. 2d 196 (calo, 1973)) the defendant bank had installed a computer system for handling cheques. For a few months it ran side by side with the manual system. Back-up facilities were also arranged at abnother bank, about two-and-a-half hours away by car. The computer broke down on the very first day after the manual system was discontinued. At first it seemed that it could be brought up into operation again relatively quickly. By the time it was clear that this would not be the case, it was too late to get to the back-up computer and to process all the work before it was required again by its normal users. The result was that cheque dead-lines could not be met, and the plaintiff bank paid on a cheque which would have been returned in the normal course of events. It was held that the bank had shown reasonable care in its precautions and in their implementation. In this way the court was able to support the introduction of new technology.

In International Business Machines Inc. v. Catamore Enterprises (5 C.L.S.R. 1025 (D.R.I., 1975) rev. 548 F. 2n 1065 (Cal, 1976)) it was found that IBM made a number of oral representations as to the quality and performance of their systems as well as two formal written agreements. When the systems failed to perform to the statisfaction of the customer, he claimed damages. Catamore was awarded damages in compensation, even though the written contracts contained several disclaimers, probably for the non-fulfilment of oral representations.

In Strand v. Librascope Ltd. (197 F. Supp. 743 (E.D. Mich., 1961)) the defendant manufacturer of computer equipment fradulently misled the purchaser about the causes of trouble with the equipment. Even though there were disclaimers in the contract the court cursorily disregarded such disclaimers and ruled in favour of the plaintiff.

Determination of Damages in Contracts and Torts

Two main aspects of determination of liability for torts/contract voilations are :

1) The measurement of damages for loss which is the result of the tort (or breach of contract in cases of violation of contract).

2) The remoteness of the loss.

The general principle would seem to be that only estimated/actuals of real losses would be awarded as damages. Remote losses are usually not allowed by courts. However American courts are seen to be more liberal in the interpretation of claims for damages than the British courts which take a more restricted view of the interpretation of admissibility of claims from considerations of remoteness.

In U.S. v. Wegematic Corp. (360 f. 2 674 (C A2, 1976)) the plaintiff made a good bargain in contracting for the defendant to supply a computer at a fixed price. The supplier found that he could not perform a that price, or indeed any other. The agency was accordingly awarded the difference between the contract price and that of the nearest comparable machine which would do the work. The loss of such bargain could easily be quantified and there was similarly little difficulty in calculating the loss of the anticipated benefit from using the machine once it had been installed since this had been quantified in the contract at a specified daily rate.

In many situations, however the quantification of damages as well as the decision of whether the loss is too remote or not present many tricky problems. Applied Data Processing Inc. v. Burroughs Corporation (394 F. Supp. 504 (D. Cohn., 1975)) is a case in point relating to computers. The

plaintiff computer service centre changed from IBM to Burroughs equipment on the faith of representations as to the suitability of the defendant's equipment for the plaintiff's purposes despite the conversion costs which it was recognised would inevitably be incurred. There ensued a succession of problems including late delivery, processing errors and general unreliability as a result of which the defendants eventually agreed to early termination of the lease. The damages fell into two classes, those which occurred before the alleged breach of contract in the expectation that the contract would be carried out satisfactorily, and those which were occasioned by the breach. Thus the expenses of converting the programs fell into the first categorty while those of running them elsewhere when the machine broke down fell into the second. The lease provided that the lessor should not be liable for indirect or consequential damages. Burroughs claimed that this excluded both categories. In its view direct damage amounted to the difference between the value of the machine as warranted and its actual value, all esle being consequential. The court rejected this argument in relation to the first category by holding that damage incurred before the breach could not be consequential upon it.

As regards the second category the court held that the distinction between 'direct' and 'consequential' damages established by the language of the contract was the same as that between 'general' and 'special' damages at common law. According to that distinction those damages which flowed directly from the breach were regarded as 'general' and those which relied upon distinctive features of the plaintiff's application are 'special'. Damages falling into the former class would be recoverable in all cases while that in the second would be recoverable only if it could reasonably have been foreseen by the defendant in the light of his knowledge of such distinctive featurer.

Activity F

Discuss with a computer centre the supply, installation and maintenance of the computer systems installed. Find out how satisfactory these are and the gap between promises and representations before purchase and after purchase. Find out whether any action was being taken by the centre on the situation if it is unsatisfactory.

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11.5 PRIVACY AND CONFIDENTIAL INFORMATION

Introduction

With the introduction of computers for information processing computerised system hold in their data bases several pieces of information relating to individuals and organisations. The security of such information is a problem which has started receiving attention. Politicians, lawyers, publishers, scientists, police and other governmental agencies are all concerned with this problem.

The concern mentioned above springs from certain notions prevalent or getting prevalent. These are :

- Privacy of individuals is being intruded into more and more in present times

- Modern technology is partly reponsible for this intrusion.

- Much of the information that is stored in computers is inaccurate and goes unchecked. How ever, users take the information to be correct.

-   The stored information is available to anyone who wishes to have it either through legal or illegal access.

-   In comparison with the speed with which technological changes have taken plac   · legal remedies available are far from adequate.

Much can be argued for and against the validity of the above propositions. Several solutions to the problems by way of legislations and otherwise have been suggested. A lot of debate is going on in different parts of the world on the subject. Some countries have taken the initiative to legislate on the subject. Some countries rely on existing legislations only.

Constitutional Provisons

There are constitutional provisions which relate to privacy of individuals in many countries either separately intheir own constitutions or by being members of multifarious devlarations, conventions and covenants. For example UK is a signatory to the European Convention on Human Rights. Article 8 of the conventions enjoins :

1) Every one has the right to respect for his personal and family life, his home and his correspondence.

2) There shall be no interference by a public authority with the exercise of this right except such as in accordance with the law and is necessary in a democratic society.

in the interests of national security, public safety or the economic well being of the country, for the prevention of crime, for the protection of health or morals, or for the protection of the rights and freedoms of others.

Similarly article 12 of the Universal Declaration of Human Rights provides :

1) No one shall be subjected to arbitraty interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation. Every one has the right to the protection of the law against such interference or attacks.

Article 17 of the International Covenant on Civil and Political Rights provides :

1) No one shall be subjected to arbitrary or unlawful interference with his privacy, family, home or correspondence, nor to unlawful attacks on his honour and reputation.

2) Every one has the right to the protection of the law against such interference or attacks.

Alaska provides in its constitution that the right of people to privacy is recognised and shall not be infringed and that the legislature shall implement that section.

Specific Legislation

Specific legislations on privacy are also available in certain countries. These range from the very general, such as the Privacy Act 1974 in the US to the very particular such as the Post Office (Data Processing Service) Act 1967 in UK.

The Fair Credit Reporting Act 1970 of US may be regarded as the first direct legislation in the field of informational privacy to have been inspired by the outcry against computerised record keeping. The Privacy Act of 1974 has sought to build on the foundation of the Fair Credit Reporting Act.

The FCRA came into existence following various complaints of the practices of credit bureaus including in proper methods of data collection, improper selection of subject matter, improper evaluation of data, refusal to disclose data to those affected by it, refusal to correct inaccurate data, or to complete incomplete data, and improper use especially in disclosing the information to those for whom it was never intended, and still more especially to government agencies like the F.B.I. and I.R.S.

The Act distinguishes credit reporting for such items as loans from investigative reporting for insurance or employment purposes.

The broad scheme of the Act is to inform the subject of an investigative report that one is being compiled and any one prejudiced by a credit report of the reason. The subject is then entitled to disclosure of the nature and substance of the information in the file, the names of the recipients of the report and in the case of a consumer, but not in that of an investigative report, the sources from which it was compiled. The subject can then demand a reinvestigation of a disputed item, have it deleted if it is recognised to be inaccurate, have a brief statement included in the file in the case of an unresolved dispute, and have notice of such changes sent to recipients of the original report. Further provisions require reports to be made only with consent of the subject, in response to a court order or to those with a bona fide business need; that obsolete information be excluded; that adverse information be reverified after a period of three months; and in the case of public information included in an employment report either that the subject be notified or strict procedures be maintained to ensure that the information is current. Disclosures to government agencies is permitted only to the extent of identifying matter. Enforcement is by a mixture of criminal and civil penalties reinforced administratively by the Federal Trade Commission, in lieu of ordinary tortious liability which is excluded.

Similar legislation, though not as detailed as the FRCA was enacted in UK under the Consumer Credit Act 1974. Other countries can be expected to initiate such legislation. However considering the nature of the technology and the fast changes that it is undergoing it may not be possible for legislation to catch up with the violation of privacy which the use of computer technology can perpetuate. In developing countries where protection under law is heavily delayed for a variety of reasons, even if legal protection were to be available only few can make use of them. Computer professionals and users have to follow certain codes of practice so that they desist from the use of the technology to violate the privacy of others.

Activity G

Enumerate by reflection the different ways in which information about yourself in one or more computers can affect you harmfully.

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11.6 SUMMARY

At each stage, from purchase to disposal of a computer, knowledge of the applicable laws is a helpful aid. This unit discusses the laws which govern purchase, sale and possession of not only the hardware but also the system and application software of computers. Apart from contractual obligations, this unit also discusses some fo the more important legal aspects pertaining to computers like patents, copyright, etc. Tortious liabilities arising from the use of computers is also discussed. Finally, this unit discusses the legislative and other initiative taken by some countries to safeguard individual rights to privacy in the context of information storage and retrieval using computers

11.7 FURTHER READINGS

Tapper, Colin, 1983. *Computer Law* (Third Edition), Longman.

BLOCK 4 MANAGEMENT INFORMATION SYSTEM

This block comprises of three units.

Unit 12 describes the evolution of MIS in a way, leading to fair understanding of its status in the organisation. It also explains different frameworks for effective creation and successful implementation of MIS through adequate involvement and proper development of the system and skills within available resources.

Unit 13 deals with basic ingredients of MIS i.e. data and information processing, along with a historical perspective. It presents a brief account of Data life cycle leading to information through processing or manipulation. The concepts cost, value and quality have been discussed under Information Economics.

Unit 14 deals with the systems view of information and its control. Structure and designing of a desirable MIS has been discussed, to facilitate the internal operation of the organisation and information flow therein.

UNIT 12 AN MIS PERSPECTIVE

Objectives

After going through this unit, you should be able to:

● understand the main features of a Management Information System (MIS)
● have an idea about the development of MIS and its present status in the organisations
● appreciate different viewpoints regarding applications of MIS in organisations.

Structure

12.1 Management Information Systems-An Introduction

12.2 Historical Background

12.3 Status of MIS in Organisations

12.4 Framework for Understanding Management Information Systems

12.5 Summary

12.6 Self-assessment Exercises

12.7 Further Readings

12.1 MANAGEMENT INFORMATION SYSTEMS AN INTRODUCTION

The subject of management information systems evokes emotions on a wide spectrum ranging from disdain to rapture. It would be no exaggeration to say that few areas of management have stirred more acrimonious debate. A large part of the controversy, however, is a matter of semantics. It boils down to sharply differing notions of what constitutes a Management Information System. Some people have used the term to describe systems in which a manager' has instantaneous access to detailed pieces of information regarding the entire organisation. Some see it merely as an appendage to the accounting system which blends into the usual financial type of summary statements. Usage of the term sometimes includes any information processed by computers. Definitions that are most useful in practice are those which emphasise the use that is made of the information provided by an MIS rather than the technology or methodology employed in collecting and disseminating the information. We will, therefore, adopt the following definition, which closely parallels those given by Kanter (1) and Davis (2).

A Management Information System is an integrated man-machine system that provides information to support the planning and control functions of managers in an organisation.

Let us make a few remarks in elaboration of this definition:

1). The output or an MIS is information that subserves managerial functions. If a system provides information to persons who are not managers we will not consider it as part of an MIS. For example, an organisation often processes a lot of data which it is required by law to furnish to various government regulatory agencies. Such a system, while it may have interfaces with an MIS, would not be a part of it. Instances of such systems are salary disclosures and excise duty statements. By the same token to sophisticated computer-aided design system for engineering purposes would also not be a part of an MIS.

2)   An MIS deals with information that is systematically and routinely collected in accordance with a well-defined set of rules. This implies that an MIS is a part of the formal information network in an organisation. Information that has major managerial planning significance is sometimes collected at golf courses. Such information is not part of MIS, however. One-shot market research data collected to gauge the potential of a new product does not come within the scope of an MIS by our definition because although such information may be very systematically collected it is not collected on a regular basis.

3)   The information provided by an MIS assists managers to make planning and control decisions. Let us clarify what we mean by planning and control. Every organisation in order to function must perform certain operations. For example, a car manufacturer has to perform certain manufacturing activities, a wholesaler has to receive and dispatch goods, a municipal corporation has to provide water to its area of jurisdiction. All these are operations that need to be done. In addition to performing these operations, an organisation must make plans for them. In other words it must decide on how many and what type of cars to make next month or what commissions to offer retailers or what pumping stations to install in the next five years. Also an organisation must control the operations in the light of the plans and targets developed in the planning process. The car manufacturer must know if manufacturing operations are in line with the targets and if not, he must make decisions to correct the deviation or revise his plans. Similarly the wholesaler will want to know the impacts that his commissions have had on sales and make decisions to correct adverse trends. The municipal corporation will need to control the tendering process and contractors who will execute the pumping station plans. The diagram below depicts the relationship between operations, planning and control

Figure I :   Relationship Between Operations, Planning and Control
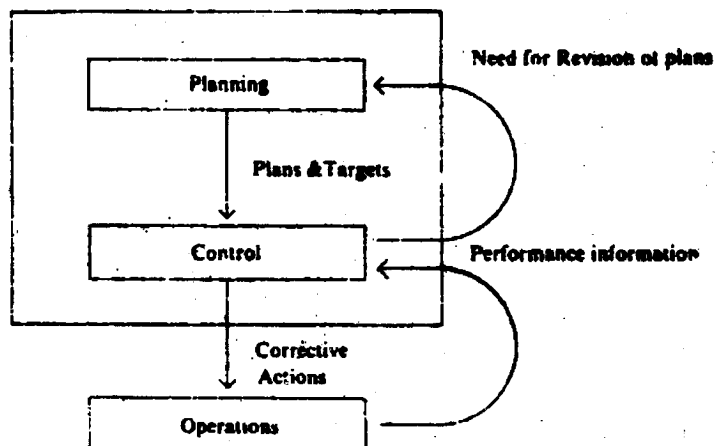
By our definition an MIS is concerned with planning and control. Often there are elaborate systems for information that assists operations. For example, the car manufacturer will have a system for providing information to the workers on the shop floor about the job that needs to be done on a particular batch of material. There may be route sheets which accompany the raw materials and components in their movement through various machines. This system per se provides only information to support operations. It has no managerial decision-making

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significance. It is not part of an MIS. If, however, the system does provide information on productivity, machine utilisation or rejection rates, then we would say that the system is part of an MIS.

To take another example, the wholesaler may have a computer system to send out bills to his retailers. If this was all that the system did, it would only be supporting operations. If, however, the system uses the bills to produce information on sales, profitability and retailer performance, it would qualify under our definition as part of an MIS. We will see that often systems that provide information on operations can be the basis for information for planning and control. However, we must be careful to realise that in and of themselves, they are not management information system no matter how sophisticated the technology employed.

4)   An MIS includes all the ingredients that are employed in providing information support to managers in making planning and control decisions. Managers often use historical data on an organisation's activities as well as current status data to make planning and control decisions. Such data comes from a data base which is contained in files (paper or electronic) maintained by the organisation. This data base is an essential component of an MIS. Manual procedures that are used to collect and process information and computer hardware are obvious ingredients of an MIS. Less obvious, but equally important are the computer programme used to process information, and operations research models employed to marshall the data to provide highly processed information to support decisions. These also form part of the MIS. In summary, when we say that "an MIS is an integrated man-machine system that provides information to support the planning and control functions of managers in an organisation" we mean that it is a system which:

● subserves managerial functions
● collects information systematically and routinely
● supports planning and control decisions
● includes files, hardware, software and operations research models.

2.2 HISTORICAL BACKGROUND

Having clarified what we mean by an MIS let us examine its historical roots. Surprisingly, Management Information Systems are in fact as old as the oldest writings in the world. The oldest evidence of writing by man discovered so far consists of clay tablets excavated at Sumer in Mesopotamia and dated approximately 3000 B.C. These contain records from an inventory system carrying information on receipts and issues made to individuals from a temple grain store. In fact, many historians believe that writing arose in response to the need for such management information. For example, W.H. McNeill, Chairman of the Department of History at the University of Chicago, says:

" At first, Sumerian priests used writing mainly to record deposits and withdrawals from temple store houses. A persistent problem here was how to find ways to record the names of the men who engaged in these transactions. Eventually the effort to record individual men's names in recognizable form induced the priests to resort to equivalences between syllables in men's names and the sound of some easily pictured word. Then by developing enough standard syllable pictures the scribes would easily learn to record all the sounds of ordinary

He goes on to add:

"It seems probable that all known forms of writing derive directly or indirectly from the Sumerian invention."

But why is MIS a subject of great interest today? There are two principal reasons for this.

Firstly, organisations have grown in complexity to levels which are unprecedented and information plays a vital role in holding together and coordinating organisations. Information is the mortar that holds together the edifice of the modern multi-division, multi-location, multi-product organisations. The role of the management information system is very similar to that of the nervous system in animals.

One notices that with evolution of creatures of greater structural complexity and functional specialisation, the nervous system too grows greatly and becomes critical in the survival of the animal. It is said that one of the reasons for the extinction of dinosaurs was the poor capability of their nervous system at low temperatures. One has only to imagine an organisation in which one department, say production, does 'not speak to' another department, say marketing, to realise the fundamental importance of information in coordinating the activities of an organisation. Indeed, management is nothing if it is not coordination and control. Despite this fact it has only been lately that management has paid any explicit attention to its information processes. Until recently information occupied the status that oxygen did before lavousier's discovery of the gas-it was both vital and unrecognised.

The second reason is the advent of the computer. Computers are able to both access and record information and perform calculations at speeds which are almost unbelievable. Even older (1960 vintage) computers can access information at a rate higher than 20,000 characters per second from magnetic tape which would correspond to reading and writing about 400 pages of an average sized book in one minute! When it comes to calculation, the computer is even more of a whiz kid. It can do about 50,000 multiplications in one second! These figures are not for unusual computers but for very modest-sized older models. More recent computers have add times in nanoseconds. A nanosecond is the time taken by light travelling at 186,000 miles per hour to move a distance of one foot! But it is not only the speed of computers but rather the reduced cost of information handling made possible with computers that has launched them into the management environment. It is a striking fact of computer technology that between its arrival on the management scene in the mid fifties and today, the cost of information processing (for arithmetic as well as filing and retrieval) has decreased by at least two orders of magnitude. It is as if the cost of an airplane ticket from Bombay to New York had dropped from $ 800 to about $ 8 in 20 years! Or the cost of the average automobile had dropped from Rs. 20,000 to Rs. 200.

It is clear that the sort of tehnological environment provides a challenge to management. Traditionally management had to think of managing four resources: money, materials, men and machines. It must add a fifth resource to this list, namely 'information'. In fact, some researchers in management have gone so far as to define a manager as a translator (transducer) of information into decisions.

12.3 STATUS OF MIS IN ORGANISATIONS

Traditionally management information systems have not really been designed at all. They are the end product of a process in which manual systems are automated in a piecemeal fashion.

The choice of applications is largely dictated by what similar companies are doing with computers or else such areas are taken up where the operational problems are most visible. Generally what may be called as MIS is nothing but a limited analysis of data captured through routine data processing applications. Thus analysis of invoice data leads to a sales analysis system in which region-wise, outlet-wise, product-wise sales is reported periodically. Similarly a few reports on overstocked, or out of stock items from the stores accounting data pass for an inventory control system.

Such applications may result in benefits which outweight costs of computerisation in a marginal way. However, this does not represent a use of computers which will have the maximum pay off for the organisation.

12.4 FRAMEWORK FOR UNDERSTANDING MANAGEMENT INFORMATION SYSTEMS

The information processes in an organisation ar labyrinthine and without some overall map to guide our steps in studying them we should soon be lost in a mass of unstructured detail. Such maps are provided by general frameworks that seek to sharpen important distinctions in the kinds of information that support managerial decisions. A number of such frameworks which, in our opinion, provide the most insight from a pragmatic standpoint are discussed below.

Robert Anthony has delineated a framework which distinguishes between the different types of planning and control process that typically occur in organisations. His basic thesis is that thinking of planning and control as two separate and homogeneous activities in an organisation is not only meaningless but positively dysfunctional. Instead of this segmentation of management planning and control activities into two categories of planning and control, Anthony suggested that the area of management planning and control be segmented into three categories, resisting the "natural temptation to use as the two main divisions: (1) planning (roughly), deciding what to do, and (2) control (roughly), assuring that desired results are obtained". The three categories suggested by Anthony are:

1) Strategic planning
2) Management control
3) Operational Control

Essentially, according to Anthony, planning and control activities are so closely inter linked as to make the separation of these activities undersirable and meaningless. Instead, according to him, it makes much more conceptual and practical sense to link together planning and control activities which are similar and inter-twined.

Anthony's definitions of these three sub-species of planning and control are:

1) **Strategic Planning** is the process of deciding on objectives of the organisation, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use and disposition of these resources.

2) **Management Control** is the process by which managers assure that these resources are obtained and used effectively and efficiently in the accomplishment of the organisation's objectives.

3) **Operational Control** is the process of assuring that specific tasks are carried out effectively and efficiently.

Anthony's departure from the traditional concept of separate planning systems and control systems is diagrammed in Figure II (a) and (b) respectively.

Figure II (a): Traditional Segmentation of Planning and Control Systems

ORGANISATION
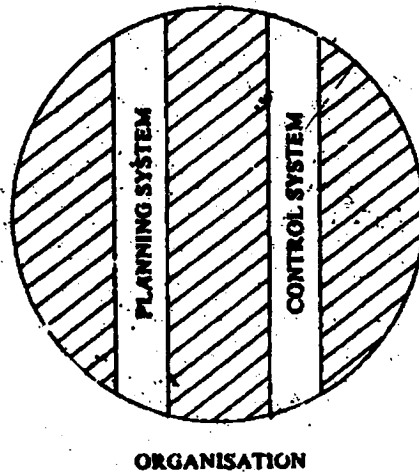
Figure II (b): Anthony's Framework of Planning and Control

ORGANISATION
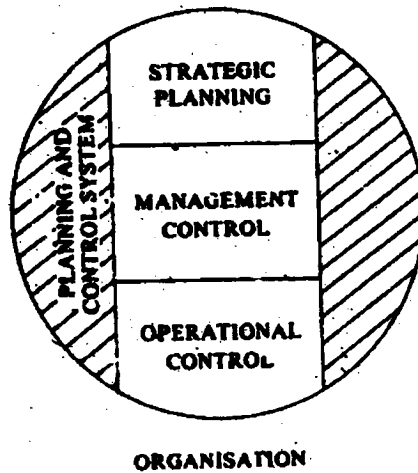
It is useful to clarify the above definitions with some examples. The table below gives instances of planning and control activities in different functional areas classified according to the above definitions.

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	Strategic Planning	Management Control	Operational Control
Production	Location of a new factory	Determining the product mix for a monthly production programme	Scheduling specific jobs on specific machines in a shift
Marketing	Entering the Export market	Media planning for advertising expenditures	Planning sales contacts to be made by a sales man in the next week
Finance	Raising capital by issuing new shares	Determining maximum levels of credit for customers	Determining what action to take against nonpayment by a specific customer
Personnel	Deciding on changes to be made in the organisation structure	Determining who will be promoted to fill a vacated post at middle and lower levels in the organisation	Determining which workers will be on each shift

Anthony's framework enables us to understand the characteristics of information needed to support the three types of planning and control processes.

The table below depicts these characteristics and highlights the substantial differences in information required for strategic planning, management control and operational control.

Information Characteri ...	Strategic Planning	Management Control	Optional Control
1. Volume	Low	Intermediate	High
2. Level of Aggregation	High	Intermediate	Low
3. Frequency of use of a particular type of data	Low	Intermediate	High
4. Currency requirement	Low	Intermediate	High
5. Accuracy	Low	Intermediate	High
6. Scope	Wide	Intermediate	High
7. Source	Significant amount from external sources	Mostly Internal	Entirely Internal

8. Predictability of use*	Low	Fairly High	Very High
9. Variability with user**	High	Intermediate	Low
10. Distance of user (in Organisational terms) from sorces within organisation	Far	Fairly close	Close

* How far in advance can the information that will be needed for a decision be stipulated?
** For a given decision, how much of the information considered necessary i.kely to vary from one individual to another.

Another framework which is useful in structuring our understanding of an MIS is one provided by Simon. Whereas Anthony's framework is concerned with the objective of the decision-maker, i.e. what the manager is trying to do, Simon's framework examines the process of decision-making i.e. how does the manager make decisions.

Simon breaks down the process of making a decision into three stages.

1) **Intelligence:** This is the stage in which the decision-maker recognises that there is a problem or opportunity that requires him to make a decision.

2) **Design:** This stage covers the determination of the alternative actions that he could take to resolve the problem or exploit the opportunity.

3) **Choice:** This stage is concerned with the process by which one of the alternatives generated in stage-2 is singled out to be pursued.

With this framework we can distinguish between three major classes of decisions. Programmed decisions are those in which all stages are handled by following a preset well-defined procedure. These decisions are repetitive and routine which arise often and are capable of being modelled mathematically in their entirety. The classic example would be inventory ordering decisions.

Non-programmed decisions are those where none of the stages is amenable to handling by a well-defined, pre-specified procedure. (These decisions are novel and difficult to structure in logical-mathematical terms. They have to be treated de novo whenever they arise.) An example would be the decisions to set up a new factory or launch a new line of products.

Semi-programmed decisions are those in which at least one and no more than two of the above stages can be handled by a well-defined preset procedure. An example where the intelligence phase is well-structured would be the diverse kinds of variance analysis. Here comparison with a budget or standard is undertaken in a well-defined way to signal the need for a decision. Subsequent stages of design and choice, however, are not handled by a set procedure.

Zani's framework draws upon the earlier two frameworks. He argues that effective MIS can only be designed in a top down fashion, viewing the organisation's information needs from the vantage point of managers who will use it rather than in a 'bottom up' manner which automates existing clirical procedures.

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According to Zani, the important determinants of MIS design are:

- Opportunities and risks
- Company strategy
- Company structure
- Management and decision-making processes
- Available technology
- Available information sources

Opportunities, risks, competencies and resources, plus the strategy derived from them, yield the company's organisational structure. This structure sub-divides the essential tasks to be performed, assigns them to individuals, and spells out the interrelationships of these tasks. These tasks, and the organisational structure they compose, determine the various information needs of the company.

Every organisation must understand its key success variables which are activities on which the company must score high for it to succeed. For example, a textile company in fashion market must focus on product promotion, understanding customer response to product and monitoring competitive changes. Whereas a mill selling grey cloth (unprocessed) must focus on manufacturing and distribution costs.

The key success variables name the key tasks of the company and thus help identify the priorities for information system development. The system must provide information that makes the individual manager's performance of these tasks easier and better.

These tasks could be related to strategic planning, management control or operational control. The content and frequency of reports that will provide the necessary information for key task must be identified through an analysis of the decision-making processes. Here the frameworks proposed by Anthony and Simon prove to be useful.

Zani advocate participative process of MIS design where top management and functional managers help in understanding critical areas of operations, identification of specific information requirements. To fulfil this role properly, managers must be aware of the major sources of information, of alternative methods of supplying data, and of the impact of the major changes of information techonology. The major contribution to information systems in these areas, of course, must come from the information and data-processing specialists.

Using the framework, then, encourages understanding of the critical areas of operations, identification of specific information requirements, and recognition of the technological, economic and personnel constriants within which an MIS develops. As important as anything else, perhaps, is the fact that systems are of necessity dynamic, changing with the environment and the organisation.

In designing an MIS there are two types of situations one may come across.

If the organisation has no experience of computing, applications which will create the maximum impact on the organisation can be identified by using Zani's framework. Key success variables are however seldom obtained through a questionnaire survey of managers. Data on environment, past company performance must be analysed and discussed to identify key success variable. It is sometimes useful to pen down a quantitative measure of such variable.

For example the performance of a textile unit can be summed up through two indicators-contribution per loom shift and fixed cost per loom shift. Similarly the performance of a shipping company may be measured as gross operating profit per day per voyage. Precise definitions of performance indicators enables the analyst to understand and quantify the likely impact of improvement in different tasks of planning and monitoring.

An analysis of the company's key success variables can be done only after a thorough understanding of the company's operations. Consultants and vendors who do not spend adequate time in understanding the operations are unlikely to throw up applicaiton areas which will create the maximum impact. They are likely to suggest 'off-the-shelf' applications. For such applicaitons use standard software which is available.

For a company getting into computerisation for the first time, a list of applications would have to be generated, keeping in view a 4-5 year perspective on the basis of which a suitable configuration would be decided. However the development and implementation of the applicatiohs would have to be done in a phassed manner. The first few applications must be those, which can create an impact on the performance of the organisation, are quick to implement with the least amount of changes in the existing procedures and systems. Initial success can make the later implemeniation of complex and more involved systems easier.

For organisation which have been into data processing and would like to graduate to MIS, the choices are somewhat limited. Existing computer technology manpower and past experience with computer applications all such factors will condition the future growth.

By and large an effort is made to create useful data bases which capture data during the execution of routine data processing systems. Such data are then analysed to produce periodic planning report for monitoring.

Examples of such systems are the sales analysis based on invoice processing; inventory control based on stock accounting; costing and profitability analysis on the basis of financial accounting systems. Of course marginal additions to data fields, new coding structure, revised procedures are introduced to make the data base and reporting more useful.

Factors Facilitating Implementation of MIS

A few factors which will increase the chances of a successful implementation of MIS are:

1) Involvement of top management in the computerisation effort, in defining the purpose and goals of computers within the organisation.

2) Selection of an EDP Manager who has the political skills to involve managers in choosing application areas, identifying information needs and designing reports

3) A computer staff which has interdisciplinary skills in computers, management and operations research.

4) A balanced expenditure on hardware and software.

12.5 SUMMARY

This unit has given you a fair understanding of the main features of a Management Information System in Organisational Context, describing its various functions, importance and relationship with planning, control and operations in an organisation i.e. what an MIS is and what it is not.

Further, the unit systematically leads you to the prevailing status of MIS in organisations, discussing the ever growing need of information and its proper handling (processing), which in turn led to the development of MIS and advent of computers therein to cope with the hazards faced in coordinating and managing the organisational challenges. We have also discussed different viewpoints about the MIS given by some management scientists.

12.6 SELF-ASSESSMENT EXERCISES

1   Critically evaluate the status of MIS prevailing in your organisation in the light of the understanding you have developed from this unit, and also propose adequate measures to improve it.

2   In what respects do the three models of MIS, discussed in this unit, differ significantly? Describe in brief.

3   What do you understand by programmed, semi-programmed and non-programmed decisions; describe with the organisational examples, you have come across?

4   How do you differentiate between planning and control in operations of an organisation?

12.7 FURTHER READINGS

Kanter, J., 1972. *Management Oriented MIS*, Prentice Hall Inc: Englewood-Cliffs.

Davis, G.B., 1974. *MIS Conceptual Foundations, Structure and Development*, McGraw Hill: New York.

Zani, W.S., 1973. "A blue print for MIS", *Harvard Business Review*.

UNIT 13 INFORMATION NEEDS AND ITS ECONOMICS

Objectives

After going through this unit, you should be able to:

* have a historical perspective on data and information processing
* distinguish between data and information
* conceptualise the data life-cycle
* identify both the logical and physical ways in which data can be processed or manipulated to produce information
* appreciate the primary aspects of cost, value and effectiveness as they relate to data and information processing
* appreciate mathematical information theory.

Structure

13.1 INTRODUCTION

Some of the dawn of civilisation, people have required information to aid them in their personal battle of survival as well as in their attempts to manage their organisations. Though for centuries man lived on earth without keeping records, it became necessary for man to adjust with the growth of social organisations. As tribes grew into nations, trade and commerce developed. Historians have traced some type of record keeping and data processing back to about 3500 B.C. when in Babylonia, merchants were keeping records on clay tablets. At about the same time, the ancient Egyptians made a great improvement in record keeping when they developed papyrus (the fore-runner of paper) and a sharp pointed pen called a 'calmus'. Today merchants and all of us still keep records and process data, but the technology by which data is processed has had a quantum leap forward especially in the last fifteen to twenty years. The world has gone through the agricultural revolution, industrial revolution and we are in the midst of the so called 'information' revolution.

13.2 GROWING NEED FOR INFORMATION

There were two primary reasons for processing data before eighteenth century. First there was a natural desire of men to keep an account of their possessions and wealth as exhibited by the Babylonian merchants. Second reason for processing data before eighteenth century was essentially because of governmental requirements for compiling administrative survey data for raising taxes and conscripting soldiers. Around fifteenth century Luca Pacioli developed the double entry book keeping system, the fore-runner of our modern financial accounting systems.

With the dawn of the industrial revolution, the basic tasks of production shifted from home and small shops to the factories. With the advent of factories, other service industries like marketing and transportation grew. The increasing size and complexity of the organisation prohibited any one individual from effectively managing them without some data and its appropriate processing. As factories grew in size it necessitated the need for more sophisticated capital goods, equipment, plant and machinery, requiring large investments. On one hand, management needed more information for internal decisions while investors, on the other hand, needed information about the organisation, its soundness, health and credibility of its managerial performances. In spite of the technological developments, there is an ever increasing pressure for more and more information.

Granting of loans, credits etc. created a need to maintain accounts receivable, accounts payable etc. It has now become statutory for any type of organisation to display certain financial statements like a balance sheet, profit and loss statement etc. duly audited and certified by chartered accountants.

There was a swing from integration to fragmentation and now we are trying to integrat again. Most organisations were run by single individuals. In government, this figure wa⁣s a ruler/king, but in business it was the owner. However, with the increasing size and complexity in government, parliaments evolved and took away many of the king's powers and duties. Bureaucratic groups were established and made responsible for specific areas, thereby resulting in erosion of authority of the central figure and fragmentation of responsibility. In business, the owner began by managing his own concern. But as the business diversified and grew, it became necessary to delegate authority to other men. The communication lines and their length increased. The result was that the owner often had very little knowledge and control of what decisions were made at the lower levels. More people at the lower levels got involved in their immediate problems losing sight of the organisation's overall goals. Fragmentation had thus become a necessary evil. The situation as of today, however, is that there is a visible movement back to some type of an integration because of the advent of technology in the form of computers and electronic data processing.

The executives in Indian industry, though they complain of many things, have three areas in common. The first is personal income tax. The second is the increasing amount of paper work and the third is the paucity of 'information' available for their decision-making. At the first glance the second and third complaints seem contradictory. On the one hand, information is pouring in through paper submerging the executive while on the other hand there is not adequate information for rational decision-making. "Water, water, everywhere but not a drop to drink!" This contradiction is present because there is abundant data' but a great paucity of 'information'.

In general usage, the terms data and information are often used interchangeably. However, there is a difference between data and information.

13.3 DATA

Data are a set of isolated raw facts, figures, statistics, unrelated and uninterpreted. Data could be defined as a collection of numbers, letters or symbols that can be processed, maintained or produced by a management information system (MIS) Data may not be organised, may not add to our knowledge and may not surprise us. Organisational activities like sales, production, billing, collecting amounts due, and assigning personnel are examples of activities that use data. Data items have value only if they are useful in the performance of organisational activities. A tray of cards representing sales invoices by itself means very little to the sales manager. Sometimes many reports are generated through data processing systems and placed on the management desk. This could be compared to a daily newspaper printed without headlines or spacing between words-an avalanche of data, but a paucity of information. Now what then is information?

13.4 INFORMATION

Information is the result or product of processing data. It provides knowledge or intelligence. It contains an element of surprise, reduces uncertainty and triggers off action. Information is an occurrence or a set of occurrences which carry messages and when perceived by the recipients via any of the senses, increase their state of knowledge.Information is the behaviour-initiating stimuli between sender and receiver. Information is in the form of signs that are coded representations of data. Data becomes information when it is processed and placed in some context. Information is the 'stuff' of paperwork systems just as material is the 'stuff' of production systems. In fact the relation of data to information is that of raw material to finished product. Information for one person may be the raw material for another. Information is now considered a resource on the level of money, materials, men, machines, methods, markets and managements. Thus information resources could supplement the existing resource list of M's by introducing messages and moments in the context of information resource management. Information resources (in the sense of stored data of all types) are re-usable.

Realistically, information communicates the state of a situation, but the perception can differ significantly between users. Information containing the same message content and quantity communicated in the same way and at the same time does not mean that it will be used similarly by the receivers. This could depend largely upon the perception, background and prejudice of the users.

Information is information only to the extent it serves the needs of the manager. It is significant for him only if it can add to his knowledge in planning the operations and help him in discharging his personal responsibility. If the data is properly organised, the manager will be able to react to it. If the data is not properly organised, it will not be helpful to him in solving various managerial problems. Since a manager has multifarious responsibilities the time at his disposal is limited. Therefore, his information needs should be identified and only that data which can be helpful to him should be accumulated and supplied to him.

Activity A

List down five elements in an organisation which you would term as data and/or information and why?

1. ....
  ....

2. ....
  ....

3. ....
  ....

4. ....
  ....

5. ....
  ....

Information Classification

We can classify information found and used in an organisation into the five groups as follows:

i) **Action Versus Non-action Information:** Here a non-action information is synonymous to data. Action information requires the recipient to do something when information is received.

ii) **Recurring Versus Non-recurring Information:** Recurring information is one which is generated at regular intervals such as periodic reports. Non-recurring information is typified by some special kind of studies to aid in management decision. This is of a non-repetitive type nature.

iii) **Documentary Versus Non-documentary Information:** Documentary information is that which is preserved in some written form or available on microfilms, punch cards, magnetic tapes, floppy disks, accounting reports etc. Non-documentary information is transmitted orally or received by an individual observation.

iv) **Internal Versus External Information:** The distinction here is obvious. It will be seen in the subsequent unit that different managers at different hierarchies in the organistaion require different blend of internal and external informr ;on.

v) **Historical Information Versus Future Projections:** The distinction here is again obvious. The historical information could be futile, unless it can be used for future projection.

13.5 INFORMATION FROM DATA

Data Life-cycle

We can think of data having their own life-cycle namely, data generation, data manipulation, transmission of data (and communication of information) and storing/retrieving and reproduction of data.

The generation of data could take place internally and/or externally. This data has to be captured by recording of data from an event or occurrence in some form such as sales slips, personnel forms, purchase orders etc.

The captured data would have to be stored either in person's mind or in a document or in a 'mechanical' or electronic device, microfilm, punched cards/tapes or in a device of some suitable form before they may be operated upon or utilised.

Stored data would have to be retrieved by searching out and gaining access to specific data elements from the medium where it is stored.

Retrieved data may be converted or reproduced to a different form of storage or presentation format by way of documents reports etc.

Data are also constantly being transported to the user in processed form. It is transferred to storage from the source, then processed and passed on to the user, who again return it to storage after working on it, which becomes available for further retrieval.

The randomly accumulated data has to be sorted and classified to reveal appropriate information. For example, sales data can be classified product-wise, territory-wise, salesperson-wise etc. Such a classification will give the sales data more meaning.

Sometimes aggregation or synthesis of many pieces of data to structure a meaningful whole or complete report is often required.

Processing of data might entail quite a bit of manipulation and calculations involving addition, subtraction, multiplication, division etc. based on certain formulae. Computations might have to be performed for deriving employer's pay, customers bill, financial ratios etc. Management science/operational research models might be used for determining optimal product mix, aggregate planning and economic order quantity determination.

Data stored must be utilised on some occasion by some one at some point of time, otherwise there is no point in putting in on inventory. When data is finally put in a usable form it can be retrieved and turned into information at appropriate time for decision-making.

Some type of a continuous verification and evaluation of data ought to be taken because there is also an economic aspect of cost of processing data versus the value of the information. Therefore, data files should be continously monitored to eleminate useless data.

It is important to destroy data following its evaluation or use. Destruction of data records may be on a purely routine basis following one time use or may occur in review of old records. Destruction is the terminal stage or the end of the data life-cycle.

The data life-cycle is portrayed in Figure I.
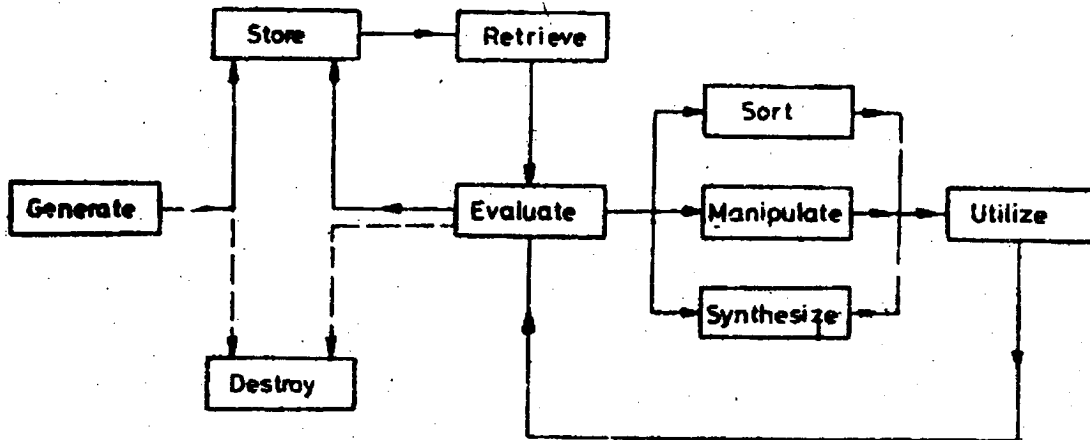
Data Processing Methods

Every organisation whether business, government or social requires a certain amount of paper work or data processing which can be done in a variety of ways. In the past, data processing consisted of manual procedures whereby the data operations were performed by hand with the aid of basic devices such as pencil, paper, slide rule etc. Then came the electro-mechanical method which is actually a symbiosis of man and machine. Then came the use of typewriters, cash registers, time clocks etc.

The punched card equipment method came into use along with the 'unit record system', the principle being that data concerning a person, object, or event is normally recorded (punched) on a card. A number of cards placed logically and sequentially in a deck was termed a 'file'. There was considerable reduction in the manual intervention. However, it was only after the development of the electronic computer that one machine became capable of performing most of the data operations without intermittent human intervention. Today data processing is generally assumed to be computer or electronic data processing (EDP). Computer systems were used initially in many organisations to perform essentially the same functions as ADP (Automatic Data Processing) systems.

The computer simply means a configuration of input devices, a central processing unit (CPU) and output devices. A major innovation in the development of CPU was the stored programme concept. A computer executes only the instructions given to it at fantastic speed. They are highly suited to highly repetitive type of calculations. However, whenever judgement is to be exercised, humans remain far superior, though of late more researches are being conducted in Artificial Intelligence (AI) and the development of knowledge based expert systems. Recently significant technological developments (especially in the field of electronics) have reduced the cost and size of the computer to such an extent that organisations of almost any size can now invariably benefit by using computer data processing. Computers of various types- mainframes, minicomputers, micro-computers and personal computers are there for the asking. Though the

hardware costs are coming down, the software costs, however, are rising. Let us now figure out the cost of information.

13.6 INFORMATION ECONOMICS

Information is a valuable resource in any organisation. However, the preparation of formal information is not free; it costs money. How much should an organisation spend for information. Some type of a cost-benefit analysis ought to be undertaken. It is more easily said, than done. Difficulties occur in measuring the cost of providing the information and measuring the value of information. Information is conceptual in nature and possibly has hardly any tangible characteristics, except symbolic representations. However, let us attempt to understand some aspects of information economics.

Cost of Information

The costs of operating the information system could be categorised as follows:

i) **Hardware Costs:** This is normally a fixed or sunk cost over a relevant range in case of computer based information system. With the quantum jumps in the field of electronics, the hardware costs are coming down appreciably.

ii) **System Analysis, Design and Implementation Costs:** This again is a sunk cost. This function includes formulating a methodology for overall electronic data processing procedure. This should include the cost for preparation of programmes and the so called software costs. With computers being the 'in thing' these days, software people are pitching their costs higher and higher.

iii) **Conversion Costs:** This is a sunk cost and includes any kind of change from one method of data processing to another.

iv) **Cost of Space and Environmental Control Factors:** This cost is semi-variable. Examples of this cost are floor space, air-conditioners and dehumidifier systems, power control units, standly generator, security and so on. The size of the computers has shrunk considerably from the first generation down to the fifth generation computers. Sizes have shrunk whereas power and capabilities have increased manifold. Many mini-and-microcomputers of today are rugged enough and do not even require an air-conditioned room (like the BBC Micro's etc. which have been introduced in schools both in rural and urban settings in India).

v) **Operation Costs:** This is basically a variable cost and includes a variety of personnel, facilities and systems maintenance, supplies, utilities and support facilities costs.

These costs are often classified as either variable or non-variable costs.

Value of Information

Let us now discuss what we understand by the term 'value' of information. To be of 'value' there are certain desirable characteristics or attributes of information, quantitative and descriptive.

Information must primarily possess attributes of relevance, availability and timeliness, to have value and thus to qualify as information. Objectivity, sensitivity, comparability, consciousness, and completeness are desirable and necessary only in varying degrees. No doubt quantifiability is desired to the maximum extent possible. The quality attribute refers to the presence or absence of ambiguities in information. No doubt all information should preferably

possess 'quality'. Measures of quality are validity, accuracy and precision. These measures of quality are especially important and applicable to quantified information.

Quality is defined as excellence or fitness. It is not an absolute concept; it is defined within a context. An application has quality relative to its primary and secondary users, operations personnel, control personnel, maintenance personnel etc. Perfect quality is very costly and perhaps impossible. Since information is a critical organisational resource, low quality information has an adverse effect on organisational performance.

Even if information is presented in such a way as to be transmitted efficiently and interpreted correctly, it may not be used effectively. The quality of information is determined by how it motivates human action and contributes to effective decision-making. Information may be evaluated in terms of 'ultilities' which may facilitate or retard its use. These 'utilities' are explained below:

i)   **Form Utility:** As the form of information more closely matches the requirements of the decision-maker, its value increases. If the manager is looking for a graph depicting the sales history, he appreciates receiving the data in the graphical form rather than in tabular form.

ii) **Time Utility:** Information has greater value to the decision-maker if it is available when needed. If you make it available well ahead of time, he might forget about it. Obviously any availability after the due time might have no relevance. Therefore, greatest value is at the appropriate time when the decision-maker needs it. The difficulty is that somethimes the appropriate time is not known to the decision-maker himself.

iii) **Place Utility (Accessibility):** Information has greater value if it can be accessed or delivered easily. On line systems maximise both time and place utility. It is very important to have the information available at the place desired.

iv) **Possession Utility (Organisation Location):** The possessor of information strongly affects its value by controlling its dissemination to others. Information is power or rather one who has information has the power.

Though it is difficult to quantify the contribution of the utility of information, one surrogate worth considering is **information satisfaction** viz. the degree to which the decision-maker is satisfied with the output of the formal information system.

Bias and Error

Managers or in fact anyone, would have strong bias towards quality rather than quantity of information. It is possible to estimate the biases of the decision-makers and provide him suitably adjusted information.

Here we would like to introduce the notion of errors in contrast to bias. Errors, a more serious problem, may result from:

a) Incorrect data measurement and collection methods
b) Failure to follow correct processing procedures
c) Loss or non-processing of data
d) Wrong recording of data

e) Incorrect history (master) file (or use of wrong history file)

f) Mistake in processing procedure

g) Deliberate falsification.

In most information systems, the receiver of information might have no knowledge of either bias or errors that may effect its quality. The difficulties with errors may be overcome by internal controls to detect errors, internal and external auditing, addition of 'confidence limits' to data and user instruction in measurement and processing procedures so that users can evaluate possible errors. The first two methods attempt to reduce the uncertainty about the data and therefore increase the information content. The last two remedies provide the user with confidence limits.

Value of Perfect Information

In the decision theoretic framework, there could be decision-making under certainty where we assume existence of perfect information regarding outcomes. In decision-making under uncertainty, we assume only a knowledge of possible outcomes but no information as to probabilities. In decision theory, the value of information is the value of the change in decision behaviour caused because of availability of information less the cost of obtaining the information. Given a set of possible decisions, a decision-maker will select one on the basis of the information at hand. However, if a new set of information input changes the decision, then the value of the new information is the difference in value between the outcome of the old decision and that of the new decision, less the cost of obtaining the new information. In this context, there is also the notion of the value of perfect information. The value of the perfect information can be computed as the difference between the 'optimal' policy without perfect information and the 'ideal optimal' policy with perfect information.

The concept of the value of perfect information is useful because it demonstrates how information has value as it influences or changes decision. However, decisions are usually made without the right and appropriate information because the needed information is usually not available; the effort to acquire the information is too great or too costly; sometimes there is no knowledge of the availability of the information and often the information is not available in the form needed.

13.7 SUMMARY

In this unit we have discussed the concept of data and information. Over the years with the growing complexities and increasing competition, the pressures for information have stepped up manifold. There are various methods of processing data to give some type of information. A data life-cycle has also been explained. Data could be free, but information costs something. We have tried to explain the various costs of information. Now there must be some benefits, utility or value of information. We have discussed how the value or utility could increase depending on circumstances. It is quite difficult to qantify quite a few of the desirable characteristics of information. A brief introduction to the mathematical information theory in communication is also given. Information tries to reduce the uncertainty in a given situation. This unit is a pre-requistie to the next unit on management information systems as the concepts of desirable characteristics of information, would be particularly useful in understanding management information systems.

13.8 SELF-ASSESSEMENT EXERCISES

1   List and explain the major reasons for ever increasing need for data processing. ,

2   What impact would (i) the tecnnological revolution (ii) research and developmept (iii) product changes and (iv) the information explosions have on the need for information by management in a light commercial vehicle manufacturing company, a health care delivery system and   ing college?

3   Define the terms data and information. Discuss the difference between data and information. Give examples.

4   Take any situation in an organisation and illustrate how a data life-cycle works in such a context.

5   List the attributes that add value to information and attempt to give a system of measurement for each attribute.

6   Find a user of information in any organisation of your choice and identify some information report that he or she receives. Ascertain or estimate the cost of this report and its value. Does the value exceed the cost?

13.9 FURTHER READINGS

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UNIT 14 MANAGEMENT INFORMATION AND CONTROL SYSTEMS

Objectives

After going through this unit, you should be able to:

● comprehend and conceptualise systems basically using a classification of input, processor, output, control and the environment

● appreciate and understand the management functions at various levels in the context of relationships between management and informational needs

● define clearly the concept of management information

● apply the systems approach to analysis of organisational problems.

Structure

14.1 INTRODUCTION

Information processing is a major societal activity. It has become an important resource in all walks of life today. Whether it is industry, commerce, defence, banking, education, economics or politics, information is needed everywhere. A significant part of an individual's working and personal time is spent on recording, searching for and absorbing information. As much as 70 to 80 per cent of a typical executive's time is spent in the processing and communication of information. Information is 'live' as it is required to be updated all the time, and it is renewable. Information is substitutable and transportable and can be made to travel nearly at the speed of light in a communication network. The growth of information in the last few decades has been fantastic. It used to be said that information gets doubled every ten years. But today this period of doubling seems to be just five years. The exponential growth of information all around makes it necessary that information is probably collected, stored and retrieved in various fields so that it could be usefully exploited where and when needed. In the previous unit, we have discussed in detail certain concepts about data and information. From information let us move on to management information. What information does the manager need to manage effectively? We are interested in a system for providing the necessary management information. Thus we need to conceptualise a management information system (MIS).

The MIS is a system that aids management in making, and implementing decisions. There is quite a lot of disparity and lack of precision in this regard as can be seen by scanning literature on MIS. Whether the MIS is computer based or non-computer based, it ought to focus on managerial effectiveness.

14.2 SYSTEMS VIEW

A Change that has occurred in recent years is the adoption of the so called 'systems approach'. In the past, managers, decision-makers and problem-solvers attempted peicemeal solutions, thinking in an isolated compartmentalised fashion independent of other operational units in the organisation. Today besides professional managers, political administrators have also become aware of the need for adopting an integrated holistic perspective by adopting the systems approach to problem-conceptualisation and decision-implementation.

Systems Concepts

Today we find everyone talking of systems - the transport system, edcuational system, healthcare delivery system, defence system, economic system, communication system, management informa-gon system, transaction processing system, decision support system, computer systems, etc. We are in the midst of an era of systems so to say. But what exactly do we mean by a system?

What is a System?

A system is an organised or complex whole. It is an entity, conceptual or physical, which onsists of interdependent parts or components. It is this interdependency which is a character sti of the parts of the system. It is an interlocking complex of processes characterised by many reciprocal cause effect pathways. A system is a complex of elements or components directly or indirectly related in a caspal network. This brings in the notion of some type of feedback and control to see whether or not the system is in a position to achieve the goals/purpose/objectives of the system. Any system must have an objective or a set of objectives or a hierarchial set of objectives. In a large context, a system is an assembly of procedure, processes, methods, routines techniques etc. united by some form of regulated interaction to form an organised whole. In fact no system, unless it be a totally closed system, can exist in isolation.

A system is made up of sub-systems which may be composed of further sub-systems. We could carry on this refinement till we arrive at the so called 'black box' level which is some perceptible manageable level. Just as a system is made up of sub or sub-sub-systems, it itself is part of a super or supra system. This could be termed as the environment in which the system operates. The forces in the environment impinge on the system while the system itself exerts pressure outwardly on the environment thereby having some sort of a dynamic equilibrium at the boundary which separates the environment from the system.

We can graphically depict the above narrative description in the form of Figure I.

Let us give an illustration in the context of Figure I. Well, one could think of an industrial system or a factory system. A factory system has various sub-systems like the production sub-system, the financial sub-system, the marketing sub-system and the personnel sub-system. Now a production sub-system could consist of sub-sub-systems of production control, materials control, quality control etc. The materials sub-sub-system can be further broken down into 'black boxes' say purchas-ing, stores, transportation etc. In turn, the factory system is part of the larger economic system of the country which would be the so called superior or supra system.
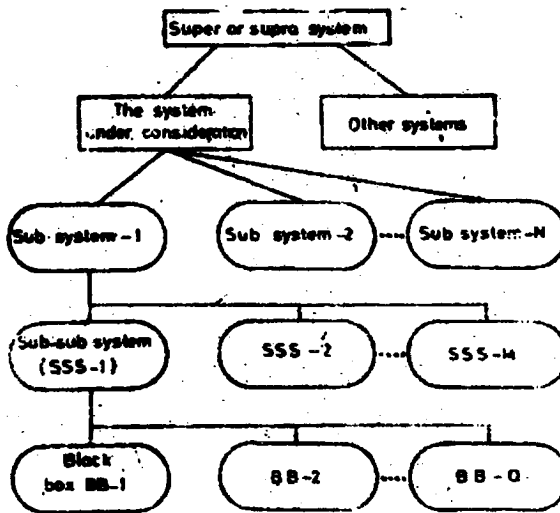
Figure I: Hierarchy of Systems

Activity A
Think of atleast three examples in the context of Figure I.

....

....

....

(a)

(b)
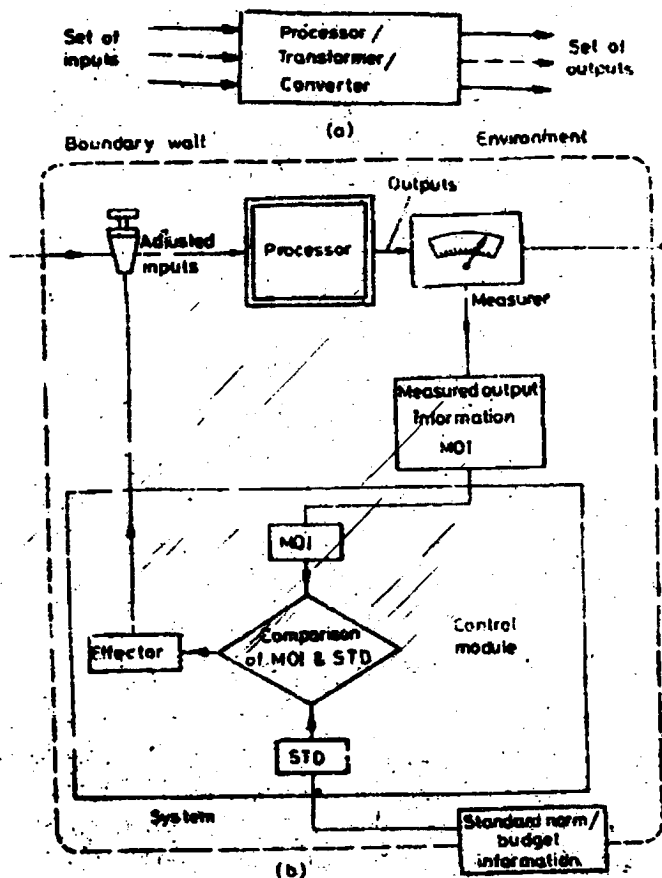
Figure II: Basic Systems Module

Further we could give yet another example in the context of Figure II. Data could be a set of input into a data processing system which would process/transform/convert the data into output or information. One could think of raw material entering as input into a production system which is converted/transformed or processed into an output i.e. some final product.

Activity B

In the context Figure II, give atleast three examples mentioning the inputs, the processor and the set outputs.

Input	Processor	Output
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .
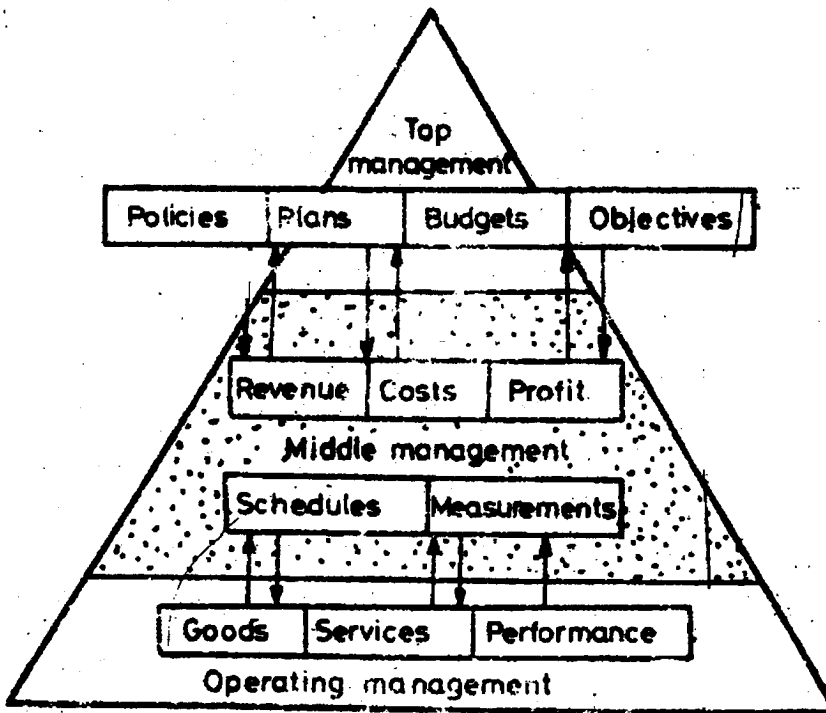
Figure III: Interaction of Management Levels

Continuing the example further in the context of Figure III this time, the quality of the finished product could be measured by comparing it with the standard specifications of the finished product. Depending on the deviations or variances the manager can then adjust the quality and quantity of the raw materials. The environment of the factory system under consideration could be other factories, competitors, customers, markets, sociopolitical and cultural factors, government etc.

14.3 ROLE OF MIS AT VARIOUS MANAGEMENT LEVELS

Some say that management can be understood by observing what managers do. Managers get the work done through others. Management can also be understood by the type of functions a

manager performs. A manager usually performs the following functions: Planning, Organising, Staffing, Directing, Coordinating, Reporting and Budgeting. In fact management is a process of achieving an organisation's goals and objectives by judiciously making use of resources of men, materials, machines, money, methods, messages and moments (the last two in the context of information being a vital resources to the manager/decision-maker).

Management can also be seen as structured into three hierarchical levels namely, top level, middle level and bottom level or strategic, tactical and operational levels, respectively. Although lines of demarcation are not absolute and clear-cut, one can usually distinguish certain layers within the organisation which are characterised by the classical pyramidical type of structures as shown in Figure III. Top management establishes the policies, plans and objectives of the company as well as a budget framework under which the various departments will operate. These factors are promulgated and passed down to middle management. They are translated into specific revenue, cost and profit goals particularly if each department works under a cost or profit centre concept. These are reviewed, analysed and modified in accordance with the overall plans and policies until agreement is reached. Middle management then issues the specific schedules and measurement yardsticks to the operational management. The operational level has the responsibility of producing goods and services to meet the revenue, profit and other goals, which in turn will enable the organisation achieve its overall plans and objectives.
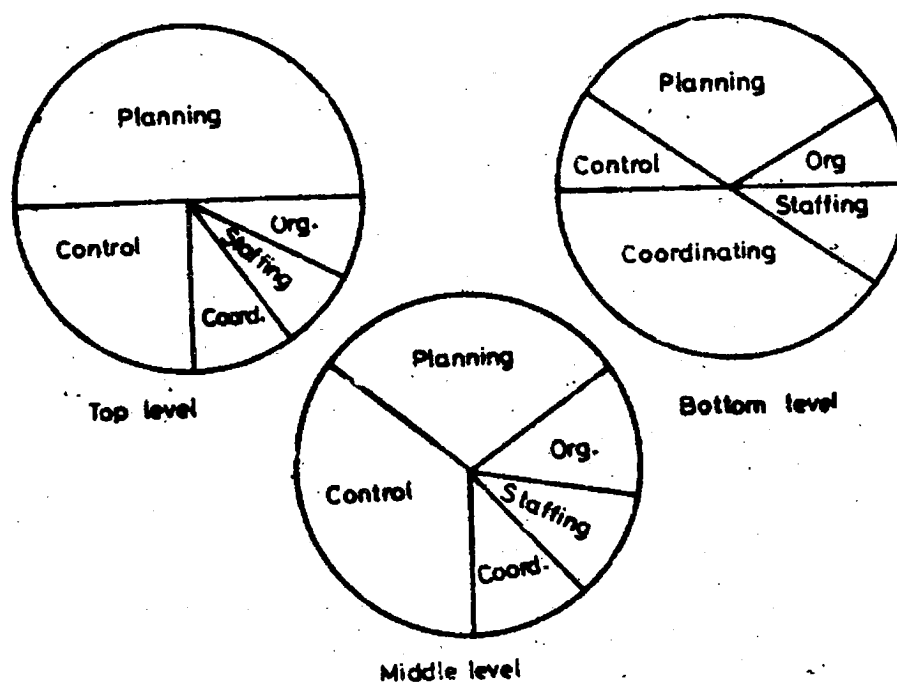
Figure IV: The Allocation of Management Time

The hierarchical view of management is important for two reasons: information needs tend to be different at different levels of management and the amount of time devoted to any given function varies considerably with the level as can be seen in Figure IV. The job content at various management levels is further elaborated in Table 1.

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In the context of MIS, management can perhaps be best defined as a process of (i) selection of objectives (ii) judicious allocation of resources (iii) determining operational plans and schedules (iv) keeping control of progress and (v) evaluation through feedback. Each of these areas require certain decisions to be made.

Thus we take strategic decisions at the top level, tactical decisions at the middle and operational decisions at the junior level. As can be seen from Table 1, the type of problems and deicisions at the junior level are quite deterministic and structured, so we can have programmed decisions.

But as we move to higher level, situations become fuzzy, ambiguous and unstructured, and thus we are faced with non-programmed decisions. We find that with the introduction of computers, we have gone about routine EDP type of an activity for the essentially programmed decisions that take place at the operating level. Perhaps with the rapid advances that are taking place in the field of electronics, communication and computers, we might have good progress in the field of AI (Artificial intelligence) and accordingly devise knowledge based expert systems which would be helpful at the strategic level to cater to non-programmed complex type of decision-making situations.

Table 1
Job Content of Management Levels

Character	Top Management	Middle Management	Operating Management
1 Focus on planning	Heavy	Moderate	Minimum
2 Focus on Control	Moderate	Heavy	Heavy
3 Time Frame	One to Five Years	Up to a year	Day to day
4 Scope of activity	Broad	Entire functional area	Single sub-function or subtask
5 Nature of activity	Relatively unstructured	Moderately structured	Highly structured
6 Level of complexity	Very complex, many variables	Less complex, better defined variables	Straightforward
7 Job measurement	Difficult	Less difficult	Relatively easy
8 Result of activity	Plans, policies and strategies	Implementation schedules, performance Yardsticks	End product
9 Type of information utilised	External	Internal, reasonable accuracy	Internal, historical; high level of accuracy
10 Mental attributes	Creative innovative	Responsible, persuasive, administrative	Efficient, effective
11 Number of people involved	Few	Moderate number	Many
12 Department divisional interaction	Intra-division,	Intra-division, inter department	Intra department

Source: J.Kanters "Management Information Systems". 3rd Ed., Prentice Hall: Englewood-Cliffs.

Though the classic pyramidical structure is generally acceptable, unfortunately in the modern complex organisation this neat, militaristic, configuration seldom'(!) fits the reality. Under conditions facing modern management the strategy and the control tend to become more remote from the resources that are geographically spread and organisationally diverse. Between the decision-maker and the resources lie systems-of people and data handling equipment - that can distort, delay, amplify, and dampen messages. External to the enterprise, interest groups-in government, consumers, labour representatives, other national and international agencies are involved in an information exchange. The modern manager must be capable of managing his information systems for strategic planning, management control and operational control.

Let us now see what the structure of a management information system is.

14.4 STRUCTURE OF MIS

Few concepts have been more vague and misunderstood as the definition and scope of an MIS. Many experts think that an MIS is the c,omputerisation of clerical work. This is incorrect. Others hope that some day it might be possible to have an all knowing expert computer system which will provide answers and decisions for complex problems when a manager/executive simply presses a few buttons. This view would perhaps remain a dream. An MIS is a means for connecting the managed operating systems by exchange of information. An MIS is more than a set of ideas or concepts. It is an operational system performing a variety of functions to produce outputs which are useful to the operating personnel and management of an organisation. Managers have always had 'sources' of information, the MIS provides a system of information. It is imperative to realise that a systems approach to managing is necessary 'to complete in today's world. The systems approach to management must precede the design and use of an MIS. The computer is only a competent, or a tool of the MIS, not the MIS itself or the central focus of MIS. Management must take an active part in the design of the MIS. Participatory design process is advocated. Technical knowledge of the computer, though preferable, is not necessary for the manager to perform his role in the design of MIS. The essence of MIS is integrated planned systems are and not "the islands of mechanisation" or data processsing systems,

Davis and Olson define MIS as an integrated user machine system for providing information to support operations, management and decision-making functions in an organisation. The system, if it is computer based, utilises computer hardware and software, manual procedures, decision models and preferably a data base. A data base is a centrally controlled integrated collection of logical ly organised data. The underlying concept of a data (bank) base is that data needs to be managed in order to be available for processing and i ive appropriate quality and value. Over time, the concept of a single highly integrated system was demonstrated to be too complex to implement. The MIS concept is now veering around to that of a federation sub-systems developed and implemented as needed but conforming to the overall plan. Thus rather than a single global MIS, an organisation may have many related information systems which serve managerial needs in various ways.

MIS is an organised method of providing past, present and projected information relating to internal operations of an organisation and external intelligence by good environment scanning techniques. All organisations have some kind of information system even though

some systems might be nothing more than filing cabinets and an accounts ledger. An information sy : m should have a systematic, formal assemblage of components that performs data procesing operations to (a) meet the legal and transactional data processing requirements (b) provide information to managers at all levels for carrying out their funactions effectively and (c) provide a variety of useful reports as required to internal and external constituents. If a report does not have an element of utility, why generate it or ask for it, unless it is a statutory requirement. Since the facts are too many and keeping track of them means getting bogged down in day-to-day routine matters, the managers do not have sufficient time for creative, and innovative work and for decision-making of a strategic nature. It is, therefore, imperative to ask for 'exception' reports. Perhaps it is well to introduce a brainstorming session of executives involved at different levels to specify what they are looking for, what is tobe done, by whom, by what data and in what form. It would be, worth creating confidence and mutual trust about not reporting normal things. Perhaps some type of a selective information management could be pursued somewhat similar to the selective inventory management of value based ABC analysis and critically based VED (Vital, Essential, Desirable) form.

14.5 INFORMATION NETWORK

Invariably we find information flowing from one place to another, from one decision-maker to another in an organisation. Perhaps it is, this, phenomenon which motivated Forrester to conceptualise an organisation as an **Information Network**. He observes that enterprises are very complex multiloop interconnected systems. Decisions are made at multiple points throughout the system at various hierarchical levels. Each resulting action generates informtion that may be used at several, though not necessarily at all decision points. This structure of cascaded and interconnected information feedback loops, when taken together, describe the total system. The interlocking network of information channels emerges at various points, to control physical processes such as the hiring of employees, the building of factories, and the production of goods and/or services. Every action point in the system is backed up by a local decision point whose information sources reach into other parts of the organisation and the surrounding environment. Management is a process of converting information into action-a process analogous to decision-making. Forrester conceptualises six information feedback networks in an industrial setting namely, materials, orders, money, personnel capital equipment and information. A policy is a rule that states how the day-to-day operating decisions are made. Decisions are the result or applying the policy rules to the particular conditions that prevail at any moment.

In essence, therefore, there is essentially an activity centre where certain actions or activities take place which change the level or state of the system. These activities are carried out because of higher level direction received from the managers at the decision centres which have their own set of decision procedures or norms. The combination of an activity centre plus decision centre is termed a functional unit because it performs a function. The functional unit is represented in Figure V which shows the flow of information. Hence the information system could be designed to provide information to each functional unit, in fact at each of the strategic planning level, management control level and operational level as shown in Figure VI. The information system for related functional units can be clustered into an information sub-system. An operational function is a class of anyone or more types of actions, carried on by the same or different functional units which regulate the inflow and/or outflow to or from sequence of levels as a group. A management control centre is one or more management people together with their supporting staff which acts as a decision centre for a group of functional units or for a group of subordinate management control centres.
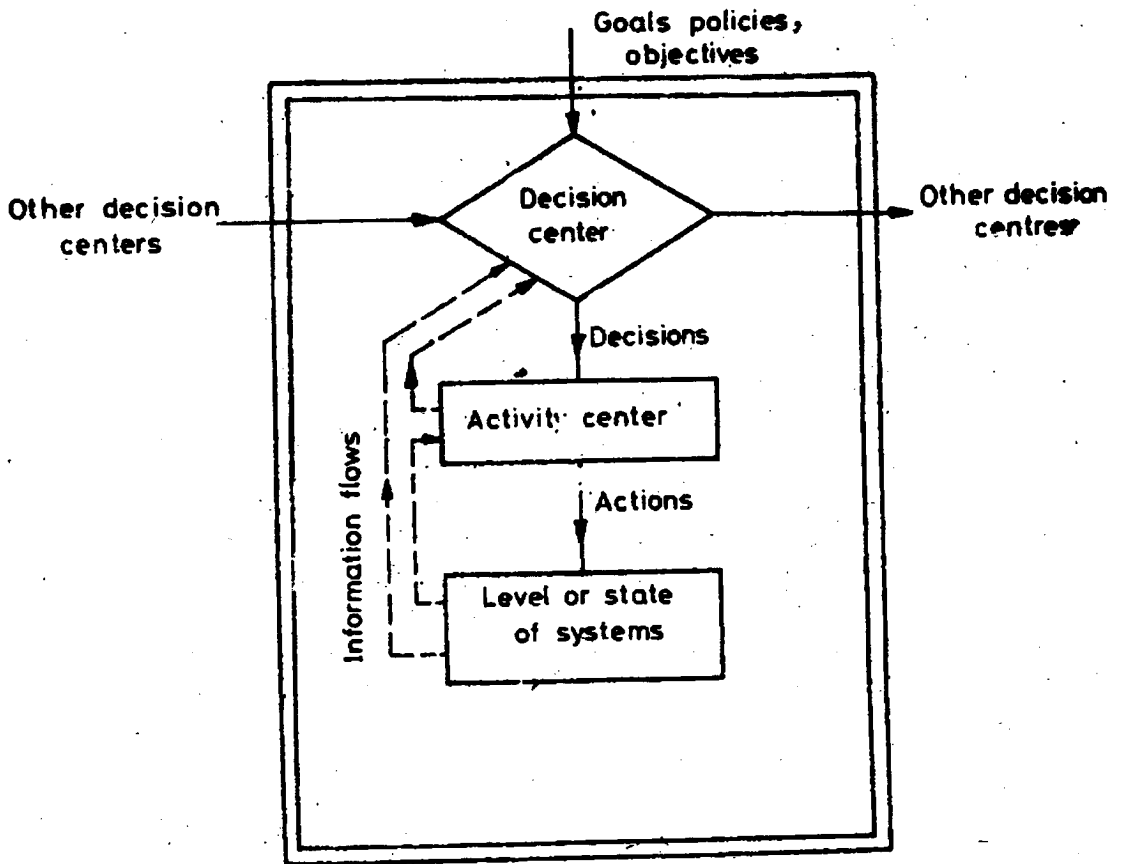
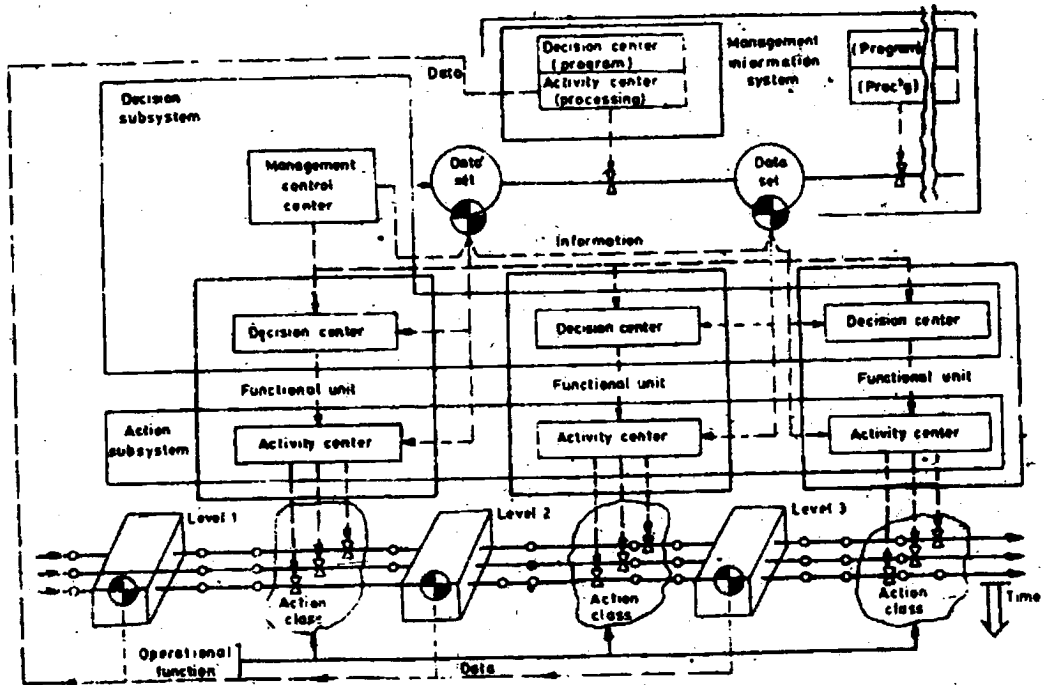**Figure V: Flow of Information in a Functional Unit**

Figure VI: Schematic Representation of Management Information System (Source S.C. Blumenthal Management Information Systems, Prentic Hall Int. 1969)

An information sub-system is a special operational function unit and MIS is an operational function whose parts (corresponding to functional units) are information sub-systems of other operation functions. We could also think of an Operational Control Module as that part of an information sub-system which supports the functional units of an operational function. A Management control module is that part of an information sub-system which supports the management control centres of an operational function. Parts of information sub-systems, termed modules, are the basic entities which help in adopting a modular approach to an MIS design. The use of modules is desirable because it allows improved project control. The modules can be written and tested separately allowing more efficient planning and implementation in phases.

The Non-formal Element

An MIS model has to reflect formal and informal flow of communication of messages/data/information. At the bottom is the physical system-the workers and all equipment and facilities used to produce the products and/or services. Internal data generated here is passed on to the information processing resources (which could be manual or computer based, preferally making use of a data base) which generate internal information formally. The internal and external environmental information is passed on to the appropriate executives/managers who also acquire on their own internal and external information on an informal, non-formal manner. Gordon Davis has conceptualised the various MIS components chart as shown in Figure VII.

Part of the MIS is available for use by anyone in the organisation, and part is private, restricted to only the person establishing it. The computer resource (in case of computer based MIS) is a part of the public MIS, whereas the information that an executive receives from telephone calls, letters and memos sent on a personal basis are examples of the private MIS. Like-wise, part of the MIS is formal and part is informal. The formal MIS is prescribed by procedure such as computer programme. The informal MIS has no spelled-out routine. The size of the four boxes in Figure VII are what it ought to be like-the largest being public-formal and the smallest
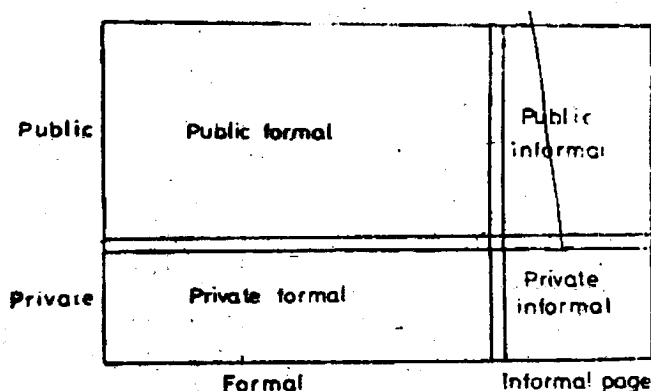
Figure. VII: Davis MIS Formal & Informal Components

being private-informal (which in an ideal case ought to be at the zero level which perhaps will never occur). Attention must be directed also to the informal organisation structure. Management should try to identify information needs that are not being fulfilled by the formal system and to incorporate as many of these flows into the formal MIS as possible. Certainly those

informal power centres of the organisation that can influence the success of the MIS should be identified and included in the design effort. One often wonders whether an MIS should straight away be superimposed on the existing organisation structure.

14.6 DESIRABLE CHARACTERISTICS OF MIS

It would be proper if we recall the desired characteristics of information i.e., accuracy, timeliness, objectivity, relevance, conciseness etc, You will discover that some of these characteristics are also the desirable characteristics of a good, effective and efficient MIS. The process of developing an MIS is never ending, as organisations strive to take advantage of new technology and methodology. The evolutionary process followed in achieving an MIS is called the MIS life-cycle which consists of phases in a sequence of planning, analysis and design, implementation, operation and control. The manager is ultimately responsible both for developing and using it. The information, specialists ought to serve as valuable technical assistants. No doubt, the information specialists play a vital role in the development of MIS. They often trigger the manager's interest in a new system by informing the manager of a new technology or method. Though the specialists recommend a particular system design, it is the manager's responsibility to approve its implementation, Once the manager makes the decision, it is the information specialist' task to implement the system. The MIS would have to preferably cater to the management/leadership styles also. If there could be greater user-involvement at all stages of the MIS life-cycle, then the end results would tend to be superior.

The system should help each executive in his decision-making process for problem identification, generation and evaluation of alternative courses of action, to acquire necessary feedback on implementing his decision and help to take corrective action. The MIS should develop the much needed management information rather than facts. It should provide relevant data, in a summarised form to the higher echelons viz. the system should be integrated through a centralised data base to cut down on redundancies, overlaps and costs Apart from the appropriateness of information at different levels, it is important to recognise that different types of information are required for planning, control, and other managerial functions. It might become necessary to computerise your system especially if you are dealing with a large complex organisation or if you find that the existing manual based MIS is not in a position to provide you with timely information. Make sure that the reports churned out from the MIS are relevant and meaningful. They should be easy to understand and read with good documentation. It is a good practice to distribute the reports only to those that genuinely need and make use of it. The MIS should be robust but at the same time it should be flexible and sensitive enough to cater to relevant charges in technologies, methodologies and the changed parameters. There should be some type of a review undertaken periodically to assess the worth of the MIS.

4.7 SUMMARY

In this unit we have tried to conceptualise, management' information and control systems. The concepts of data and information having already been outlined in the previous unit, systems concepts, and systems approach were discussd in this unit. The systems approach advocates a integrated, holistic, systematic and scientific approach. Next certain concepts of management ere visited again but discussed in the context of MIS. A manager is primarily a decision-maker and a problem - solver. Information is one of the prime resource inputs to his decision-

making. It becomes necessary to provide the right type of information to the right decision-maker at the right time. Thus the need for an effective system to provide information to management at all levels. The whole organisation could be thought of as an information network, both formal and informal, connecting various decision centres at various levels. Managers at different levels perform different managerial functions and hence require different types of information. A conceptual framework outlining the desirable features of MIS have been described which could lead you towards the design of an MIS if you do a little more reading on the subject.

14.8 KEY WORDS

Analysis: The methodical study of a problem. Especially the modularising of a problem into smaller and simpler problems. Usually used in a nonbusiness sense (such as numerical analysis, operations analysis) unless combined with a business term.

Audit: Examination and verification of records.

Binary Digit: Either of the digits 0 or 1. A single digit of the binary number system. Bit is the contraction of binary digit.

Business: The purchase and sale of goods in order to make a profit. As used in this block, business encompasses the professions and industry, any trade of goods or service, manufacture or other activity engaged in for profit. Any institution or group of people engaged in such activity.

Business System: A system used to accomplish some business goal. Typical business system include accounts receivable systems, payroll systems, banking systems and so on.

Central Processing Unit: Directs the operation of other units in a computer and performs the data manipulation and computations needed to effect the desired transformation of the input data. Frequently written CPU. When the word computer is used to mean less than a complete computing system. it generally denotes the CPU. In computers referred to as main frame.

Communication System: Used to convey data from one point to another. Consists of a message source, message channel and message receiver. Also called data transmission system data communication system and the like.

Components: A part of system. An element of a larger thing. See System and sub-system. A component is generally a sub-system unless it is too simple to be considered a system at all.

Cycle: A sequence of operations or activities that are repeated regularly (though the operations may be varied from repetition to repetition.)

Data: Some representation of facts, instructions, or concepts. Commonly represented in symbols but in computerised business systems, it is generally represented with graphics.

Data Base: Some number of files. Most data bases have names (corporate base, financial database, production data base and so on).

Implementation: The step in the system life-cycle where system design is constructed as real business system.

Information: The meaning humans assign to data. The purpose of an information systems is the production of information from data.

Installation: The step in the system life-cycle where a new business system is put into use. Also used to mean a business or computing facility.

Management by Exception: A principle of management where attention is focused only on performance. The phrase used in connection with the presumed action required where reports on performance differ from original projections. Characteristically these reports bring out 'favourable' and 'unfavourable' variances, the latter being the basis for 'Management 'by exception'.

Management Information System: A business application that collects, maintains, correlates, and selectively displays information to assist human being in decision-making. Generally denoted by the acronym. MIS.

Message: The information to be, transmissted by a communication system.

Microprogramming: Using a programme to specify the inter-relationship among the sub-systems of a computer when the computer is being viewed at the architectural level. These programs and the hardware they control are often referred to as firmware. Microprogramming permits redefinition of a computer's hardware, machine language instructions without making any wiring changes.

Module: A Part of a whole.

Organisation: Either (1) an institution, body of people organised for some purpose or the administrative personnel of a business or (2) synonymous with structure.

Storage: A mechanism into which data can be entered, in which it can be held, and from which it can be retrieved at a later time. Loosely any mechanism that can store data.

System: Some number of components that interact in such a manner that the whole is more than the sum of its parts.

Systems Analysis: The step in the system life-cycle were a detailed study is made of the need and its solutions and the environment in which they must exist.

Systems Life-Cycle: The sequence of steps through which a typical business system passes; need, conception, feasibility study, system analysis, design, implementation testing installation or conversion, production maintenance and cessation. This cycle has also been stated as

1) need,

2) conception.

3) wild enthusiasm,

4) total confusion,

5) search for the guilty,

6) punishment of the innocent,

7) promotion of non participants, and

8) need.

14.9 SELF -ASSESMENT EXERCISES

1   Discuss fully the purpose of an information system.

2   Discuss why management needs information. Is it possible for the management of an organisation to make effective decisions without the aid of an information system? Discuss.

3   "In the end, the information system must be recognised only as a foundation for human judgement, insight and inventiveness" Discuss.

4   What impact does the implementation of programmed-decision-making have on the management system of an organisation?

5   "Formal information can't do much to help top level decision-makers". Discuss.

6   Sketch and explain a schematic diagram of a system with its management constituents input relation to the environment and its information system. Choose any organisation system with which you are familiar.

7   Compare and contrast formal and informal information. Give five examples of each.

8   Visit an organisation of your choice and describe its information system. Is it based on the hierarchical or systems approach, or a variation thereof?

14.10   FURTHER READINGS

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BLOCK 5 SYSTEMS ANALYSIS AND COMPUTER LANGUAGES

This block comprises of three units.

Unit 15 deals with the design and development of Computer Based Information System in an organisation, discussing extensively the System Life Cycle.

The second Unit (16) gives the basic insight ito computer programming with the help of programming illustrations, discussing higher languages and preparation of flow diagrams before writing programmes.

The third and last Unit (17) specifically deals extensively with COBOL programming explaining in deals all the steps and other specifications involved in it.

UNIT 15 SYSTEMS ANALYSIS AND DISIGN

Objectives

After going through this unit you should be able to:

● understand the design and development of Computer Based Information System (CBIS) in an organisation

● know about the various aspects and components of System Life Cycle in a CBIS

● have an idea at nut the importance of flow diagrams in designing CBIS.

Structure

15.1 INTRODUCTION

Systems analysis and design provides a structured approach to the design and development of Computer Based Information System (CBIS). The tasks involved in the design and development of CBIS can be broadly classified into three categories, namely (i) Systems Analysis, (ii) Logical System Design, and (iii) Physical System Design. A Logical Design provides a logic for obtaining the desired outputs from available inputs. A Physical design maps the logical design onto the physical hardware of a computer system.

A Computer Based Information System (CBIS) is a set of software packages, which when executed, provides information for decision-making. Designing and developing a CBIS is one of the most important activities in any organisation, as it involves people at different levels in the organisation. Like any living organism, a CBIS also has .. iife cycle.

15.2 SYSTEM LIFE CYCLE

The various stages in the life cycle of a CBIS are described below:

Objectives: The first and the most important step is to provide a broad statement of organisational objectives, for the proposed CBIS. This is primarily a responsibility of the top management.

Feasibility: The next step is to examine the feasibility of the proposed system. This involves evaluating the costs and benefits of the system. Initially a rough cost-benefit analysis will be

sufficient for the top management to take a decision either in favour of or against the proposed CBIS.

Costs include costs of design, development, implementation and maintenance of the system. Benefits will be realised from the timely and accurate generation of required information to meet the stated objectives of the organisation. It is to be realised that a data base created for a particular CBIS application usually serves other applications as well to a certain extent. For example, a data base for pay roll accounting can be used for applications such as Provident Fund (PF) accounting, Retirement Benefits accounting, Personnel Information Systems etc. Such indirect benefits also should be considered in the feasibility analysis.

Feasibility study is a part of Systems Analysis. Experience has shown that delaying or neglecting feasibility study is one of the major reasons for the failure of a CBIS.

Systems Analysis: Systems 'Analysis is the next stage in the life cycle of a CBIS. This step involves the following:
- understanding the organisation to identify the flow of information between different levels in the organisation
- a detailed examination of the proposed system (application area) for CBIS
- identifying alternative approaches to meet the stated objectives of the system
- evaluating the costs and benefits of each alternative in detail, and finally
- choosing the 'most appropriate' alternative.

Systems Analysis involves team work and a considerable amount of time. A clearer picture of costs and benefits of alternative approaches will emerge from a detailed study of the proposed system. Involvement of ultimate users of CBIS is very crucial at this stage itself, so that the acceptance of CBIS upon implementation will be relatively easy.

System Design (Logical): Providing Logical System Design for the chosen alternative involves:
- understanding user requirements
- identifying data requirements
- suggesting a logical organisation of data, and
- suggesting a logical procedure to produce the desired outputs from available inputs.

It is very important that we understand the requirements of various users in the organisation. Users at different levels in an organisation have different information requirements for decision-making. Information requirement can be broadly classified into three groups as follows:
- monitoring and control decisions
- planning decisions, and
- policy and strategy decisions.

Detailed discussions between system designers and ultimate users is very essential to estimate users' requirements clearly. This includes identifying report contents, frequency of reporting, formating of reports and presentation of reports (tabular vs. pictorial), for each user.

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After estimating users' requirements, a system designer works backwards to identify data requirements. This includes identifying data sources, the nature and type of data that is available, and data gaps.

The next step is to establish a processing logic to produce the desired outputs from the available inputs. This step involves data flow analysis and a data processing anlaysis. Data flow analysis helps us to arrive at a logical organisation of data into computer files. A file is a collection of similar records, each record has a number of data items (fields) of informaion of a particular entity. For example, a payroll file will contain many payroll records, each record carrying the necessary data items (fields) of information of an employee, like name, designation, department, basic salary, etc.

A logical representation of data flow analysis and data processing analysis in a CBIS can be effectively provided through structured system design tools. These are:
● data flow diagrams
● data dictionary for data flow analysis
● decision tables
● decision trees, and
● structured English for data processing analysis.

These tools are highly recommended to present a well documented and self explained logical system design. These tools are explained in detail later.

System Design (Physical): While a logical design provides an estimate of processing requirements, a physical design involves mapping the logical design onto the physical hardware of a computer system. Upgrading the existing hardware and/or acquiring a new computer system if required to meet the processing requirements is also undertaken at this stage.

Subsequently, file organisation details are worked out and appropriate file organisation methods established for processing and storing data. File organisation methods can be broadly classified into two types - serial access organisation and random access organisation. These methods are discussed in detail in another unit.

A system flow chart is commonly used to present the physical system design. It is to be realised that a system flow chart is different from a programme flow chart. A detailed discussion on system flow chart is given later.

Implementation: Actual programming is undertaken at this stage to implement the proposed CBIS in the available hardware. This activity includes:
● programme development
● debugging of programmes: i.e. spotting and correcting errors in programming
● testing of individual programme modules on sample data
● implementing the entire system on the computer
● getting acceptance of the CBIS from its users
● providing user training, and
● preparing user manuals and documentations.

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This is the most time consuming activity in the life cycle of a CBIS; and is also the costliest activity. Systems Analysts have a tendency to lose interest once all the programmes are developed and tested to their own satisfaction, and not necessarily to the satisfaction of the users. This tendency is dangerous and should be avoided at all cost. It is the responsibility of systems analysts to properly document their programmes, prepare user manuals, provide user training and getting acceptance for the CBIS from its users.

Maintenance: Maintenance follows a successful implementation of the CBIS. As users develop faith in a CBIS, their demands on the system will grow. The system design should be flexible enough to accommodate future requests, refinements, modifications, and changes to suit users' requirements. Well documented logical and physical designs of a CBIS will facilitate its maintenance considerably.

The following table summarises the various activities in the development of a CBIS.

Table 1: System Life Cycle

Stage	Description
Objectives	Broad statement of objectives
Feasibility	Rough cost/benefit analysis
System Analysis	Evaluating alternatives and choosing the most appropriate alternative to meet the objectives
Systems Design (Logical)	A broad logical design structured tools like DFD, Data Dictionary, Decision Tree, Decision Table, Structured English etc. and arrive at system requirements.
System Design (Physical)	Detailed system design, taking into account available and proposed hardware - use of system flow chart.
Implementation	Programming, implementing and user documentation
Maintenance	Modifications and revision for user needs.

15.3 DATA FLOW DIAGRAM

Data Flow Diagram (DFD) is a graphical representation to depict the flow of data in a CBIS. It should be realised that a DFD provides only logical data flow and not a physical data flow.

A logical data flow in a CBIS can be explained as follows: Data orginates from a **Source**, undergoes some **Processing** and terminates in a **Sink**. The processing step may require data stored elsewhere in **Data Stores**, over and above what is supplied by the source. Similarly the output of processing may be an intermediate data store which is used for subsequent processing.

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These components of a DFD are presented graphically, using the following conventions:

● a closed square box to denote source/sink

● an open rectangular box to denote intermediate data store

● a circle to denote processing, and

● an arrow to denote the directional flow of data.

For example, consider the case of a 'pay roll accounting system, to prepare salary statements for each employee of an organisation. Data flow for such a system can be represented as shown below in Figure I.

Figure I : A DFD for Payroll Processing
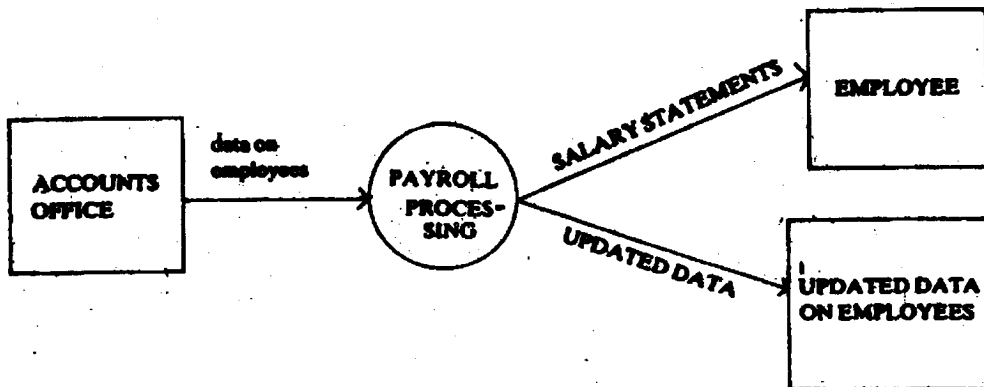
In Figure I, data on employees originate from accounts office (source), gets processed,salary statements go to employees (sink), and updated data on employees (e.g. total tax deducted, total contributions to provident fund, etc.) is stored in an intermediate computer file (data store) which is needed for subsequent processing next month.

A DFD displays data flow in a top-down approach. Therefore we start with a macro DFD and 'explode it' into micro DFDs. Care has to be exercised to provide clarity for each level of DFD. Towards this, a standard practice is

a) not to use more than one page for one DFD, and

b) not to show more than 6 or 7 circles (processing steps) in each DFD.

The following Figure illustrates this practice.

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Figure II : A DFD Payroll Accounting

Figure II : A DFD Payroll Accounting
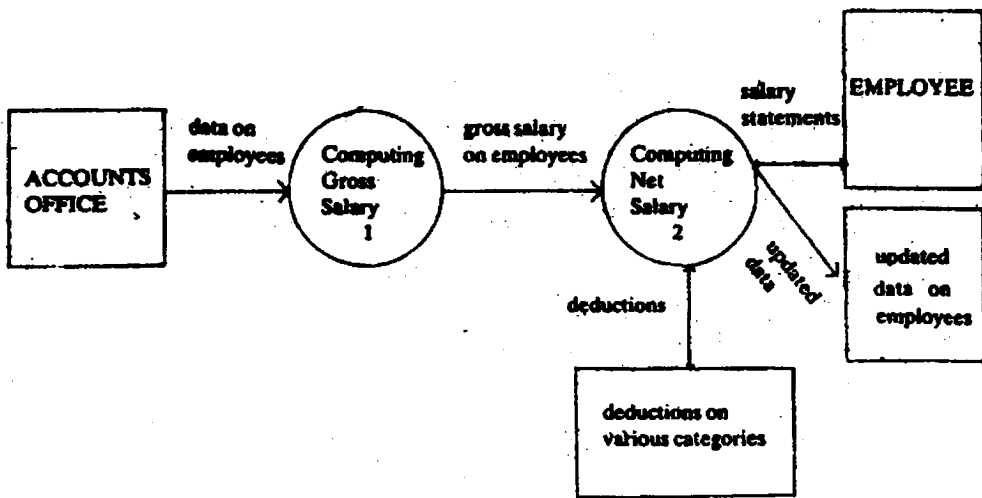
While exploding a DFD into lower levels, it is very essential to maintain a continuity and linkage between a DFD and its member DFDs. This is achieved by numbering each circle (processing step) by adopting the numbering system used in text books. In a text book, chapters are numbered 1,2,3,............... sections within a chapter have numbers as extensions of the chapter number, e.g. 1.1, 1.2, 1.3,.... and sub-sections within each section numbered as 1.1.1, 1.1.2, 1.1.3, etc. Similarly circles in DFDs are numbered as 1,2,3..... 1.1, 1.2, 1.3,....., 1.1.1, 1.1.2,......

The following Figure illustrates this numbering convention.

Figure III: Numbering Convention for Processing Steps in DFD.
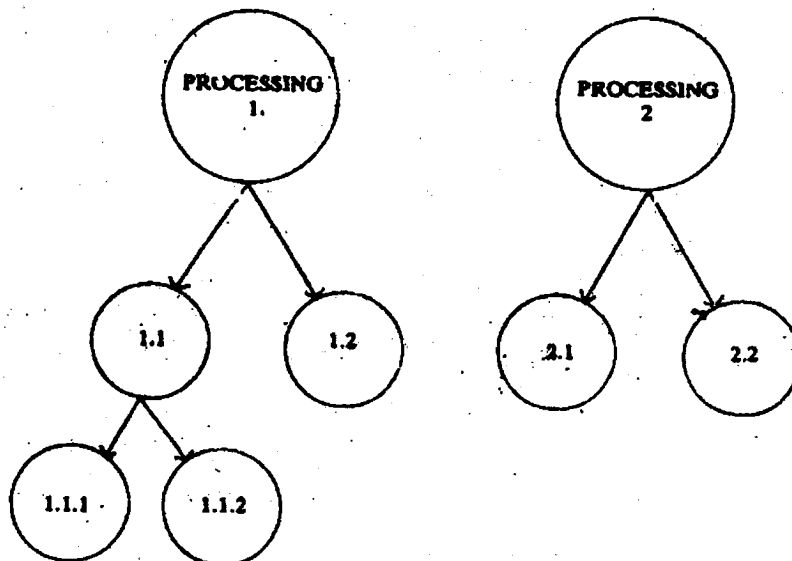
Such a hierarchical approach to drawing DFDs provides a clear logic for system design, a proper documentation of processing steps and an estimate of processing requirement.

15.4 DATA DICTIONARY

A Data Dictionary (DD) is intended to provide a complete documentation of all the elements of a Data Flow Diagram, namely data items, data stores, and data flows. Data described in a DD carries the following details.

Data type	Data item/data store/data flow
Data name	Name of data item/data store/data flow
Data aliases	Alternate names used for convenience by multiple users.
Data description	A short description of data, explained in simple terms.
Data characteristics	Characteristics of each data type.
	A data item is characterised by its type (numeric/ alphanumeric), width, etc.
	A data store is characterised by its composition (set of data items), organisation (sequential, random), etc.
	A data flow is characterised by its origin, destination, etc.

Below we describe the contents of a DD for a sample data item, data store and data flow for a CBIS on payroll accounting.

DATA ITEM

● Data type	Data item
● Data name	G-SALARY
● Data aliases	Wages
● Data description	Monthly gross salary of an employee

Data characteristics

Type	Numerical
Width	7.2
	4 digits for the rupee component
	1 digit for the decimal point
	2 digits for the paise component
Associated data stores	Payroll file
	Personnel file
Associated data processes	Payroll file
	PF accounting
	Personnel information systems
Comments	Gross salary is based on employees designation, and hence falls within a specified range.

DATA STORE

● Data type	Data store
● Data name	Payroll file
● Data aliases	Salary file
● Data description	Master file on employees for payroll accounting

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Data characteristics

Composition   EMP-NAME

                           Designation

                           B-Salary

                           Department

                           :

                           :

                           G-Salary

                           :

                           :

Organisation   Sequential file

Volume   1000 records (approximately)

Size   350 K bytes (approximately) per record

Associated data   Payroll accounting

Processes   PF accounting

Inbound data flow   _____

Outbound data flow   _____

Comments   This file gets updated every month at the time of pay roll
                           processing. On an average, about 5 records are deleted per
                           month (retiring/leaving the organisation) and about 10 records
                           are added per month (new appointments).

DATA FLOW

● Data type   Data flow

● Data name   DATA ON EMPLOYEES

● Data aliases   _____

● Data description   Data on employees required for payroll processing

Data characteristics

Origin   Accounts office

Destination   Process 1 in payroll accounting

Contents   EMP-NAME

                           Designation

                           B-Salary

                           Department

Associated data

processes   Payroll accounting

Associated data

stores   _____

Comments   _____

15.5 DECISION TABLES

A decision table displays and documents clearly the processing logic for each processing step identified in a DFD.

A decision table has the following structure.

		Combination of conditions	
Condition 1	Y		
Condition 2			• • • •
Condition 3	Y		
Action 1			
Action 2	Y		• • • •

This table is to be read from top to bottom, one column at a time. For example interpret column 1 as follows: If conditions 1 and 3 are satisfied, then take action 2.

For illustration, consider an 'accounts receivable' application in ABC Corporation. Customers are prioritised based on how much they owe to ABC Corporation and for what length of time. The following procedure is used to classify customers into A,B,C categories. A customer is a A type customer if the amount due from him is not for more than one month. A customer is C type customer if he owes at least Rs. 6,000 for a period exceeding 2 months or if he owes less than Rs. 6,000 for a period exceeding 3 months. All other customers are classified as B type customers.

This logic can be represented in a decision table as shown below:

Conditions								
Period due : less than 1 month	Y	Y						
1-2 months			Y	Y				
2-3 months					Y	Y		
more than 3 months							Y	Y
Amount due : less than Rs. 6000	Y		Y		Y		Y	
At least Rs. 6000		Y		Y		Y		Y
Actions								
Type A Customer	Y	Y						
Type B Customer			Y	Y	Y			
Type C Customer						Y	Y	Y

15.6 DECISION TREES

A decision tree is another way to document processing logic, specially when the number of alternatives is not too many.

Combinations of conditions are represented along the branches of a decision tree. The outcome of each of these combinations is given at the end of the final branch. For illustration, the processing logic followed by ABC Corporation for prioritising its customers (mentioned in section 4) can be explained in a decision tree as follows:
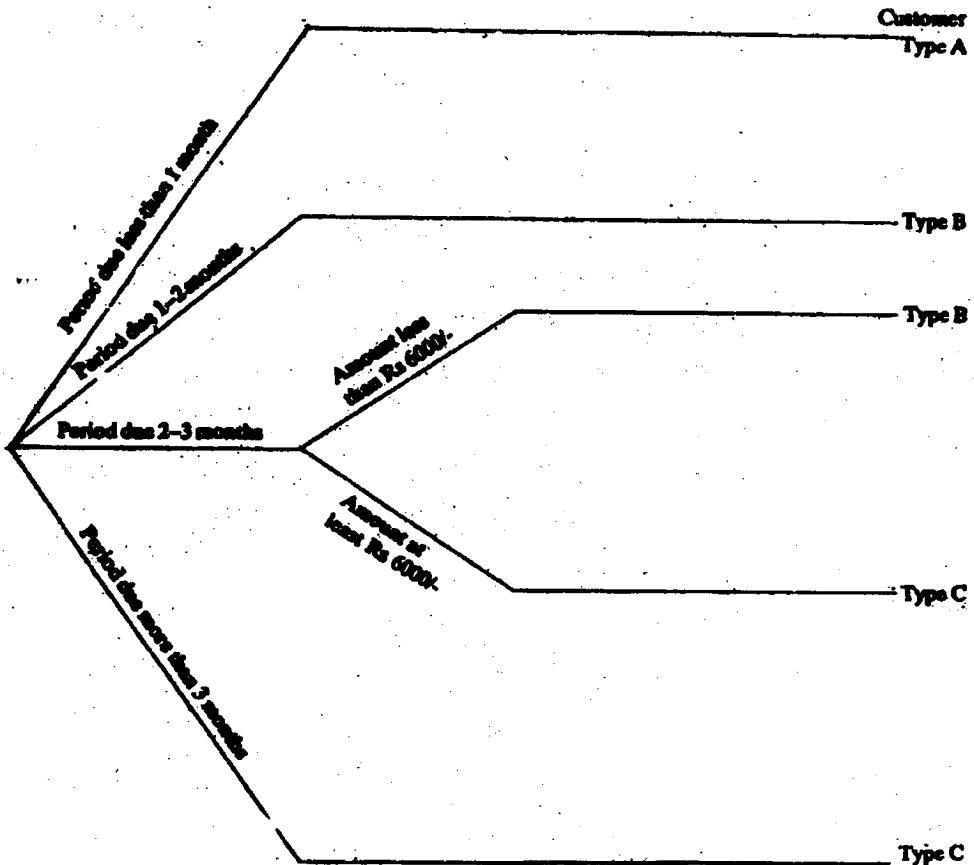
15.7 STRUCTURED ENGLISH

Processing logic can also be explained clearly in a structured English language. For illustration, the processing logic for ABC Corporation can be explained as follows:

IF Period-due is less than 1 month, then customer = A type.
ELSE

    IF period-due is less than 2 months, then customer = B type
    ELSE

        IF perioo-due is less than 3 months, then

            IF amount due is less then Rs. 6000 then the customer = B type.

            ELSE Customer = C Type

        ELSE Customer = C Type

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Structured English statements should be properly indented and aligned for readability. It is advisable to avoid long statements; if necessary break up a long statement into many short statements.

Programming, the processing logic in a higher level language, is very easy if the logic already explained in structured English. Structured programming languages like PASCAL are based on structured English statements.

15.8 SUMMARY

In this unit we have explained in detail a few structured tools to aid the logical and physical designing, developing, implementataion and maintenance of a Computer Based Information System. Decision tables, trees and data dictionary have been discussed to help logically depict the flow of data, in a CBIS, through Data Flow Diagram. Available hardware, choice of appropriate programming tools are important considerations in the physical design of a CBIS, and are discussed in subsequent units.

15.9 SELF-ASSESSMENT EXERCISES

1 What is a Computer Based Information System (CBIS)?

2 What are the important stages in the life cycle of a CBIS?

3 What is a data flow diagram? Explain its use in system design.

4 What is the role played by data dictionary in a CBIS?

5 Explain the concept of Decision Table, Decision Tree and Structured English in describing the processing logic.

6 Suppose you are designing a system to convert numerical scores (0 to 100) in a test into letter grades (A, B, C, D, F) using the following procedure.

Numerical Score	Letter Grade
Less than 40	F
40 to 55	D
55 to 70	C
70 to 85	B
More than 85	A

a) Explain the processing logic through a Decision Table.

b) Explain the processing logic through a Decision Tree.

c) Explain the processing logic through Structured English.

What is the difference between a logical design and a physical design?

15.10   FURTHER READINGS

Terrace W. Pratt, 1983. *Programming Languages Design and Implementation,*
Prentice-Hall of India: New Delhi.

Edler, John, 1984. *Construction of Data Processing Software,* Prentice-Hall
International: Englewood-Cliffs.

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New Delhi

Sanders, D.H., *Computers Today,* McGraw Hill: New York.

UNIT 16 COMPUTER PROGRAMMING

Objectives

After going through this unit, you should be able to understand:

- the basic programming illustrations, fundamentals of programming languages and writing programme in higher languages.
- developing flow diagram before writing the programme in higher languages.

16.1 INTRODUCTION

In this unit we shall explore the subject of programming. We will find that the process of programme development is intuitive and requires commonsence rather than a strong mathematical background. Clarity in logical thinking would certainly be an asset, and we believe that it can be cultivated. We shall discover programming concepts in our informal thought process while coping with computational problems. We shall then elaborate on these concepts gradually leading to formalising our thought process.

We know that a computer is normally used to solve complex problems. But if we ask a question as to what computers can really do, the answer would be, nothing more than a school going child would do with paper and pencil, that is, add, subtract, multiply, divide, compare two numbers, and likewise do some simple operations on a string of characters. That means methods to solve complex problems must be expressed in terms of these elementary capabilities of computer. That is precisely what computer programming is all about.

16.2 A PROGRAMMING ILLUSTRATION

There are two ways to cope with complex computational problems. One is to state the method to solve it directly, if we can, which is normally very difficult for a complex problem. The other is to look at the problem as consisting of several somewhat less complex subproblems. This is called refinement of original problem into its subproblems. If we can cope with these subproblems, which we can hope to do because these are some what less complex, we would have coped with the original complex problem. Coping with each of the subproblems can be

seen in the same manner as main problem, either state the method directly, if we can, or refine it in terms of further subproblems, and so on. The refinement process can go on until methods to solve all the subproblems on hand can be stated directly without the need of any further refinement.

We shall illustrate the process of stepwise refinement through an example. Consider the following problem:

```
Find squareroot of a given number
```

The above problem is far too complex at this stage to state its solution directly. Some of us may be perfectly justified in expecting computer languages to provide means to compute such mathematical expressions directly. For the time being we shall assume that no such facility exists to compute a squareroot, so that we have enough motivation to pursue the problem in all seriousness. Moreover, even if such a facility does exist, it will be in the form of a programme embedded in the computer language. We shall try to develop such a program.

Let us start attacking the problem In the following paragraph we shall just capture our thought process:

"First I must take down the 'given' number. Then may be I can guess a number close enough to the actual answer. Obviously it will be almost impossible to hit upon the correct answer on the first try. But if I am able to improve my guess in every successive try, then I should be able to get so close to the actual answer at some stage that I need not try to improve the accuracy any further. Also, since I am anyway improving may guess with every step, closeness of my first guess to actual answer may not matter much. How do I know that I am close to actual answer? If x is the given number and r is its squareroot, then,
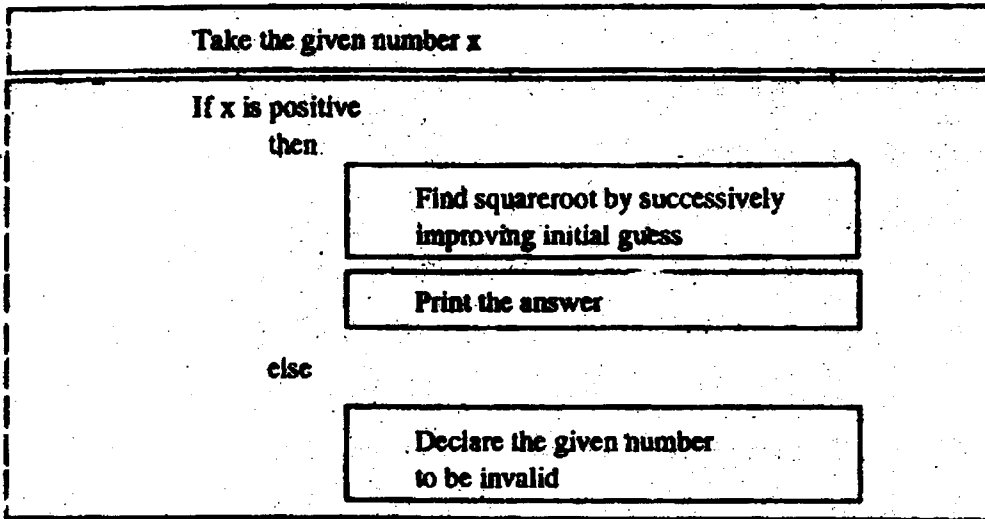
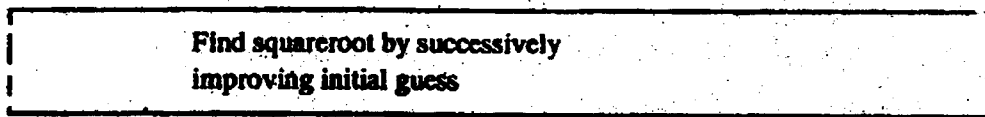$$r \times r = x$$

or alternatively,

$$r = x/r$$

The above relation gives me a very important clue to test closeness of my guess to actual answer. If I guess g to be the answer, x/g can also claim to be the answer. Unless g happens to be the actual answer, g and x/g will be at the opposite ends of the actual answer, and so their average is likely to be closer to the actual answer than either g or x/g. I can continue until the guess and the improved average guess are close enough.

My thought process has assumed that for the 'given' number the squareroot exists. From the relation r = x/r it is clear that the given number x cannot be negative. If x is negative, then r can neither be positive, nor be negative, not even be equal to zero, meaning thereby that r does not exist."

Above verbose thought process leads us to refinement of original problem in terms of somewhat less complex subproblems in the boxes as follows:
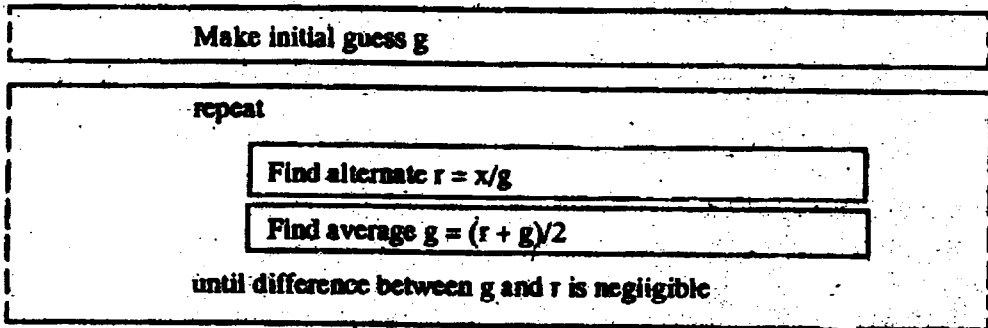
```
┌─────────────────────────────────────────────────────────────┐
│          Take the given number x                            │
└─────────────────────────────────────────────────────────────┘
┌─────────────────────────────────────────────────────────────┐
│   If x is positive                                          │
│          then                                              │
│              ┌──────────────────────────────────────┐       │
│              │  Find squareroot by successively      │       │
│              │  improving initial guess              │       │
│              └──────────────────────────────────────┘       │
│              ┌──────────────────────────────────────┐       │
│              │  Print the answer                     │       │
│              └──────────────────────────────────────┘       │
│          else                                               │
│              ┌──────────────────────────────────────┐       │
│              │  Declare the given number             │       │
│              │  to be invalid                        │       │
│              └──────────────────────────────────────┘       │
└─────────────────────────────────────────────────────────────┘
```

In the above refinement the subproblem

```
┌─────────────────────────────────────────────────────────────┐
│          Find squareroot by successively                    │
│          improving initial guess                            │
└─────────────────────────────────────────────────────────────┘
```

requires further refinement, all other subproblems being presumably capable of direct specification of solution.

Refining the above further,

```
┌─────────────────────────────────────────────────────────────┐
│          Make initial guess g                               │
└─────────────────────────────────────────────────────────────┘
┌─────────────────────────────────────────────────────────────┐
│          repeat                                            │
│              ┌──────────────────────────────────────┐       │
│              │  Find alternate r = x/g               │       │
│              └──────────────────────────────────────┘       │
│              ┌──────────────────────────────────────┐       │
│              │  Find average g = (r + g)/2           │       │
│              └──────────────────────────────────────┘       │
│          until difference between g and r is negligible     │
└─────────────────────────────────────────────────────────────┘
```

16.3 PROGRAMMING VOCABULARY

We are almost through with our stepwise refinement. In stating our refinement we have used some important words such as if _ then _ else, repeat _ until and so on. Meanings inherent in these words form fundamental concepts in programming. We shall identify few more of such words to make our programming vocabulary cover all essential concepts in programming, so that we are able to develop programs in English language. Of course, to see these programmes in action in computer we/will have to translate the English language programs into one of the computer languages like BASIC, FORTRAN, COBOL, PASCAL, C, etc. But to our pleasant surprise we shall discover that most of these languages do retain most of our vocabulory. They would differ only in strict enforcement of syntax rules and offering some advanced level conveniences to advanced programmers. Our choice of English as language to

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conceive and develop programs will enable us to appeal to our intuitive problem-solving abilities, emphasise programming concepts, and retain option of choosing any computer language or their versions. Programming in a new language would then be simply a matter of learning its syntactic rules and special features.

```
input x                      : Take the given number
  if x > 0   then            : If valid then try
      g = x/2                :    any guess would do
  repeat                     :    repeatedly improve
      r = x/g                :    alternate guess
      g = (r + g)/2          :    average of two guesses
          until abs (r-g) < 0.001   :    is it very close?
          print g            :       print the answer
      else                   : If number was invalid
          print "Invalid input"  :    say so
  endif                      :
  end                        : end of program
```

You will be delighted to know that in the above simple looking program we have covered almost all the programming concepts! Words in bold, namely,

```
input
if _ then _ else _ endif
=
repeat _ until
print
end
```

form some of the key words in our programming vocabulary. We would like to maintain that the vocabulary corresponds to English language to be used by us to develop programs. Such programs would need conversion to computer language of our choice for implementation, though conversion effort would we negligible for a modern structured computer language. Would you be surprised if we tell you that the squareroot programme developed by us in structured English language would be acceptable to Microsoft Quick BASIC (Version 3.0) on IBM PC compatible machines if we just change repeat until to do _ loop until? the Microsoft Quick BASIC 3.0 will be our official implementation language, since programs developed in structured English will require minimal conversion effort to change them to that language. For those of you who do not have access to Microsoft Quick BASIC, or who prefer BASIC of any other pedigree or any other computer language for that matter, we shall give guidelines for conversion.

Apart from key words, we have used several other programming concepts. We have used numeric constants such as 2, 0.001, and string constant 'Invalid input'. We have also used variable names x, g and r to identify various quantities required by us. We have used expressions such as x > 0, x/2, (r + g)/2 and abs (r - g) < 0.001 to compute required quantities. We have even used a standard library function abs (   ) which is normally available in all computer languages. We shall now elaborate on these terms and concepts.

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Constants

These have fixed value in the sense that 2 cannot be equal to 4. String constant is simply a sequence of characters such as 'Invalid input' which is a string of 13 characters. The numeric constant can be integer representing whole quantities or floating point number with a decimal point to represent numbers with fractional part. Constants would be probably the most familiar concept to us since we have used them in doing everything that has to do with numbers. Numeric constants can be added, subtracted, multiplied, divided, and also compared to say whether two of them are equal, not equal, less than or greater than each other.

As string constants are sequence of characters, a related strong constant may be obtained from a given one, by chopping off some characters from beginning or end or both, or by appending another string constant at beginning or end. For example, from 'Gone with', we can get 'one with', 'Gone wit', 'one with', 'Gone with wind', and so on. String constants also can be compared in a lexicographic (dictionary) sense to say whether two of them are equal, not equal, less than or greater than each other.

Variables or Identifiers

These are simply names given by us to identify the values that we deal with, e.g. the given number x, the guess g, the revised guess r, and so on. Every computer language would impose its own set of rules on identifiers restricting length of a name, an appendage character to signify type of value it represents such as numeric or string, and so on. Obviously all of them would forbid use of key words as identifiers. Some languages distinguish upper and lower cases (CAPITAL and small letters), in the sense that SURESH and Suresh are considered to be two different identifiers.

16.4 EXPRESSIONS

We know that we can express intended arithmetic operations using expressions such as x/2, (r + g)/2 and so on. Several simple expressions can even be nested together using parentheses to form complex expressions. Every computer language would give order in which various arithmetic operators are evaluated in a given expression. An expression may contain operators such as

  parentheses
  exponentiation
  negation
  multiplication, division
  addition, subtraction

The operators are evaluated in the order given above. For example, the expression

  2 + 8 x (4 - 6/3)/ - 2^4

can be considered to be evaluated as follows:

2 + 8 x (4-6/3)/ - 2^4	sub expression (4-6/3) taken up first
2 + 8 x (4-2)/ - 2^4	division 6/3 within (4-6/3) has higher priority than 4-6
2 + 8x2/-2^4	subtraction (4-2) done next

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$2 + 8 \times 2/ - 16$	(4-6/3) is now complete
	exponentiation 2^4 next followed by ~~mation~~. 1<
$2 + 16/ - 16$	8×2 and $2/ - 16$ have same priority
	but 8×2 is at left, so it scores
$2 + - 1$	$16/ - 16$ has higher priority than $2 + 16$
1	that is the final answer.

It is useful to remember order of priority of various operators. But it is safer to simplify expressions and enclose them in parentheses to avoid unpleasant surprises.

So far we have focused on arithmetic expressions. But expression is a very general concept. We mentioned earlier that apart from usual arithmetic we can compare numbers or strings. We do it by using relational operators in relational expressions. The relational operators such as:

=	equal to
<>	not equal to
<	less than
>	greater than
<=	less than or equal to
>=	greater than or equal to

have same level of priority among themselves but lower priority than arithmetic operators mentioned earlier. The relational expressions result in one of the truth values, either TRUE or FALSE. We should not confuse truth values, TRUE or FALSE with string constants 'TRUE' and 'FALSE' respectively, just as we do not get mixed up between number 235 and string constant 235'. As a number, 235 means something (i.e. a value representing two hundred thirty five), but as a string constant, '235' is a meaningless sequence of three characters. Similarly, as truth values, TRUE and FALSE represent meaning of some assertion implied by result of some relational expression. Some computer languages explicitly provide logical constants. TRUE., FALSE., and/or. YES., No. to represent these truth values. Other languages use integer constants to implicitly represent the truth values as for instance FALSE is usually represented by number 0, and any non-zero number is considered to represent TRUE. When a relational expression such as (3>5) is evaluated to be FALSE by such languages, a value 0 is assigned, whereas (5<7) would be evaluated as - 1. Now, since - 1 is a non-zero number, it is a valid representation of truth value TRUE, though some of us become uncomfortably emotional about using a negative number for the purpose. But those of us who are aware that numbers are internally represented in computer as a sequence of bits would appreciate virtues of - 1 as having all its bits at level 1. So at this stage we may grudgingly accept superiority of - 1 as a better representation of TRUE than any other non-zero number.

Note that relational expressions are capable of comparing only two values separated by appropriate relational operator. If we want to express idea such as whether number 7 happens to be within two other numbers 4 and 10, we may be tempted to write relational expression 4< = 7 < = 10. Such reasonable expectation from us may be a bit too complex for a computer language. Then we need to explain our idea in terms of simple relational expressions such as (4< = 7) AND (7 < = 10) would mean that 7 is between 4 and 10. Likewise (2<4) OR (10<2) would mean that 2 is outside 4 and 10. In the preceding examples we have joined two relational

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expressions using logical operators AND, OR to express our complex conditions to form what is known as logical expressions. Among other logical operators NOT simply negates a truth value in the sense that NOT TRUE is FALSE, and NOTE FALSE is TRUE. The logical operators have priority than relational operators. Among themselves they have the following order of priority during evaluation of logical expressions.

Operator	Meaning
NOT	Simply negates a truth value. Not (2> 5) is TRUE
AND	TRUE if both adjoining expressions are TRUE (4 < = 7) and (7 < = 10) is TRUE
OR	FALSE if both adjoing expressions are FALSE (2 < 4) OR (10<2) is TRUE as (2 < 4) is TRUE
XOR	TRUE only if one of the adjoining expressions is TRUE and other is FALSE. The XOR has same priority as OR. (4 < = 7) XOR (7 < = 10) is FALSE
EQV	This is opposite of XOR. FALSE if truth values of adjoining expressions are different (2 < 4) EQV (10 < 2) is FALSE (2 > 4) EQV (10 < 2) is TRUE·
IMP	FALSE only if preceding expression is TRUE and succeeding is FALSE. (2 < 4) IMP (10 < 2) is FALSE (2 < 4) IMP (10 > 2) is TRUE (2 > 4) IMP (10 < 2) is TRUE (2 > 4) IMP (10 > 2) is TRUE

Of the six logical operators NOT, AND, and OR are sufficient to express any logical condition. Any expression involving XOR, EQV and IMP can be converted to equivalent expression involving appropriate combination of NOT, AND and OR. So there is no cause for concern if some of us are bit uneasy about meaning of XOR, EQV and IMP. Of these XOR and EQV may have some natural appeal. But many who are new to logical expressions would find IMP difficult to swallow. To get some intuitive feel for IMP operator, remember that we shall refuse to accept the assertion. 'Truth of A implies truth of B' if A is TRUE and B is FALSE, but gladly, accept that both A and B are TRUE. However, can we refuse the assertion if A itself is FALSE? By the way, A IMP B is equivalent to NOT A OR B, which means that it is FALSE only if A is TRUE and B is FALSE, and in all other cases it is TRUE.

Although our discussion on expressions has become somewhat verbose, writing these expressions in our programs would presumably be quite natural as we are going to take English language route to develop programs. Crucial would be to grasp conditional expressions (i.e. relational and logical ones), also known as boolean expressions. They are to be naturally expected around terms such as if, till, until, and while in our thought process as they naturally imply some condition to be fulfilled.

Expressions would be our basic workhorses. Our programs would be full of them, and while executing the program, computer would be preoccupied most of the time evaluating them. But it would also be doing other things such as taking some values as input from an input device, assigning a value or result of an expression to a variable, send a value for display to a display unit, pondering to be or not to be on some conditional expression, repeating some tasks until we are satisfied, and calling some slave-programs to perform specific tasks. In the following discussion we shall elaborate on these actions.

Input statement

Syntax: input = list of variables

We used it to input 'given' number x in our squareroot program. That is what it is normally used for, to supply values to a list of variables through input device such as keyboard. On execution a question mark? would be displayed on the screen, in response to which we are expected to supply sequence of desired values matching appropriately the type (i.e. integer, floating-point or string type) and number of variables in the list.

Assignment statement

Syntax : identifier = some expression or identifier

This is the most obvious statement used for assigning value to an identifier (i.e. variable). In ASIC languages this is also known as LET statement though the key word LET is optional in most of them. Note the use of = as assignment operator. You would recall that it was also used as lational operator. Some purists justifiably object to ambiguous use of =. In Pascal, : is used for assignment instead of just = which is used as relational operator. In language C, = is used for assignment but == for relational operator! We, like in Microsoft Quickbasic, shall put up with the ambiguous use. Context of its use will hopefully resolve the ambiguity. For example, x=2=2 is expected to assign a value - 1 to x because the expression to the right of x = is evaluated as a relational expression 2=2 being TRUE!

Print statement

Syntax: print = list of variables

This is again an obvious way to display values of specified list of variables on display screen. We shall make use of print to represent generic output statement independent of particualr output device such as display screen, printer and so on. Computer languages normally provide very rich facilities for making the display as attractive as possible. Display has a touch of glamour in it that consumes more than fair share of new programmer's time and energy. Modern languages provide exotic features like full-screen display, windowing and so on that is clearly beyond the scope of this unit. You are, therefore, requested to refer to respective language manuals for details.

If _ then _ else _ endif structure: (To Be or Not To Be!)

Syntax: if (condition)

then

| statements for Task A |

else

| statements for Task B |

endif

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This is one of the most important program-structures that enables a modern programmer to develop well structured programs. Note that we are calling it as structure rather than a statement. As structure it accommodates statements corresponding to alternate tasks to be performed depending upon truth value of the condition. The structure has three components, a conditional expression the truth value of which determines the action, a then _ clause denoting task to be performed if the condition is TRUE, and an optional else _ clause with task to be performed if the condition is FALSE. It is highly recommended that the structured programs be appropriately indented to properly delineate boundaries of various clauses and structures. Our stepwise refinement will gradually and naturally unfold the program structures such as if _ then _ else _ endif and others. Each subtask taken up for further refinement has its own indentation. Recalling our squareroot program, note the clear indenting that makes the program highly readable and easy to comprehend.

```
input x
if x > 0
    then
    |       g = x/2
    |       repeat
    |       |      r = x/g
    |       |      g = (r + g)/2
    |       until abs (r - g) < 0.005
    |       print   g
    else
            print "Invalid input"
endif
end
```

Note three levels of indentations. First denotes boundary of if _ else _ endif structure. Second is then _ clause and else _ clause. Third is repeat _ until loop structure that we shall be discussing shortly. Proper indenting enables us to focus our attention on particular task that needs to be attended to.

Returning to our if _ then _ else _ endif structure after a useful dose on virtues of indenting, we note that the structure does not impose any restrictuion on contents of then or else clauses. They may have any number of and any type of program structures snugly nested within them. See for example, repeat _ until structure nested within then _ clause of if _ then _ else _ endif structure. Note that we have presented most general and useful if _ then _ else _ endif structure with multiple line then and else clauses. Other variations are single line clauses and without explicit else clause. Some languages, particularly BASIC of older vintage are hopelessly unstructured. The translated version of our structured squareroot program in one such BASIC would look like,

```
10 INPUT X
20 IF NOT (X > 0) THEN 100
30 LET G = X/2
40 LET R = X/G
50 LET G = (R + G)/2
60 IF NOT (ABS (G - R)< = 0.001) THEN 40
```

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```
   70 PRINT G
   80 GOTO 32767
   100 PRINT "INVALID INPUT
   32767 END
```

Note IF NOT (..) THEN'.. used to simulate if _ then _ else _ endif as well as repeat until loop, structures. This ambiguous use of a statement makes the program difficult to comprehend. Moreover, emphasis seems to be on navigation through program using GOTOs making then highly unreadable. More about it later. Let us close our discussion on if_then_else_endif structure by relating it to our Microsoft Quick BASIC. The structure is fully provided by the language. For some strange reason, syntaxwise it insists that the then key word must follow if (condition) in the same line, and also insists on splitting endif as end if. It extends the structure to allow use of elseif _ clause to accommodate multiple conditions. Following example would clarify the use of elseif_ clause to handle a quantity discount situation:

```
if (x > = 10000) then
           price = 10
    elseif (x > = 8000) then
           price = 10.5
    elseif (x > = 6000) then
           price = 11.0
    elseif (x > =4000) then
           price = 11.5
    elseif
           price = 12.0
end if
```

Note that elseif _ clause is part of if _ then _ else _ endif structure, making it a if_ then_ elseif _.. _ else _ endif structure. Also, note that only one of the clauses would be executed. A very close cousin of this extended structure is case _ endcase structure which we may discuss later. Other variations of this structure are single line versions using line numbers or statement labels to GOTO the desired part of the program, like the ones we have used in the example BASIC program. The use of GOTOs is inevitable in unstructured languages. But they can be and should be always avoided while using structured languages like Microsoft Quick BASIC, Pascal, C and so on, except in some unavoidable situations that we shall present later.

16.5 LOOP STRUCTURES

Obviously, purpose of a loop structure is to repeat certain task until no more repetition is desired. We shall be presenting several variations of loop structure appropriate to handle different situations.

repeat _ until structure:

Syntax : repeat

```
    Statements for
    task being repeated
```

until (condition)

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Our choice of repeat _ until was quite natural in sequareroot problem where we started with some initial guess and iteratively improved it until we were satisfied with level of accuracy. A loop structure is characterised by the body of statements to be repeated, and condition for termination of loop. In repeat _ until version the condition comes after the body. The condition is tested after the body is executed, if it is evaluated as FALSE then body is executed again. The execution of the body is repeated until condition is evaluated to be TRUE. That reminds me of a joke about a doctor who prescribed for the patient to

    repeat

            The Dose

    until (the patient dies)! That's a cruel one?

Note that in repeat _ until version the body would be executed at least once since decision to terminate the loop is taken only after executing the body. Most structured languages do provide repeat _ until loop structure, perhaps using different key words. The Microsoft Quick BASIC calls it do _ loop until. In unstructured languages this may be simulated by placing a statement

    IF NOT (condition) THEN label

after the body where label refers to the first statement of the body as we have shown in our translation of sequareroot program to unstructured BASIC.

while _ endwhile structure:

            Syntax: while (condition) do

            ┌─────────────────────────────────────┐
            │ Body of statements   │
            └─────────────────────────────────────┘

                endwhile

In this version, the condition is tested before every execution of the body. The decision made is whether to execute the body. The body is executed if the condition is evaluated to be TRUE, after which the condition is tested again. The loop is active as long as the condition evaluates to TRUE, and terminates when the condition is evaluated to be FALSE. Unlike the repeat _ until version, the while _ endwhile does not guarantee the execution of the body at least once. In case the condition is found to be FALSE for the first time, the body will be altogether skipped. To illustrate while endwhile structure we could have developed our squareroot program as:

    input x
    if x > 0
        then

            g = x/2
                while (abs (g - x/g) > 0.001) do
                        g = (g + x/g)/2
            endwhile
            print g
        else

            print "Invalid input"
    endif
    end

Note that in this version if our initial guess itself is close enough then we do not need to execute the body. The while _ endwhile loop structure does a sort of

    "Look before you loop" syndrome!

Just as repeat _ until, most structured languages do offer the while _ endwhile structure, albeit with different key words. The Microsoft Quick BASIC gives two syntax options, the do while _ loop and while _ wend with identical meaning. For the benefit of unstructured languages the while _ endwhile loop structure may be simulated by placing

IF NOT (condition) THEN label

statement before the body, where label corresponds to a statement just after the last statement of the body.

repeat _ endrepeat structure:

Snytax: repeat

```
┌─────────────────────────────┐
│  Body of statements          │
│  including provision         │
│  for exiting the loop        │
└─────────────────────────────┘
```

endrepeat

Two previous versions of the loop structure were characterised by the condition being either after or before the body. The repeat _ endrepeat caters to the third possibility where termination condition can be known only inside the body. The structure does not provide for any termination condition, in the sense that it is truly an infinite loop structure. It is the responsibility of the body to force an exit out of loop. For example, suppose that we want our squareroot program to compute as many squareroots as user cares to compute before he chooses to terminate the program by inputing a zero or a negative number. We can put our previous program in a repeat endrepeat loop structure with a provision to exit if x is less than or equal to zero.

```
repeat
   input x
   if x < = 0
      then
         exit
      else
         g = x/2
         while abs(g - x/g) > 0.001 do
             g = (g + x/g)/2
         endwhile
             print x, g
   endif
endrepeat
```

Note the use of exit statement inside the body of repeat _ endrepeat loop structure. In general exit statement is meant to terminate innermost loop enclosing it.

Usually, repeat _ endrepeat is not explicitly provided in structured languages as it can be very easily simulated with a forever TRUE condition in repeat _ until or while _ endwhile structures. The Microsoft Quick BASIC does provide the repeat _ endrepeat structure as do _ loop without any until or while key words in its syntax. It enables termination of such loop with exit do statement. For unstructured BASICs the repeat _ endrepeat may be simulated using

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GOTO label

statement after the last statement of the body, where label corresponds to the first statement of the body. Obviously somewhere in the body there must exist a statement such as

if (exit condition) THEN label 2

where label 2 corresponds to next statement after the GOTO label.

for _ endfor structure :

Syntax·   for var = start to finish step incr do

```
┌─────────────────────────────┐
│         ·Body of statements  │
└─────────────────────────────┘
```

endfor

This loop structure is distinctly different from the ones we have discussed so far. Unlike them, the for _ endfor structure counts the number of times the body is to be executed on the basis of number of times a control variable is incremented from start to finish in specified steps. Managing the control variable is the responsibility of the for _ endfor structure, so we need not and should not worry about assigning any value to it in the body of statements. Any attempt to do so may land us in trouble. However, the value of the control variable is available for our use as we shall see in the case of array data structure to be discussed later. To illustrate the for _ endfor structure let us overstretch our squareroot example further. Suppose for some strange reason we would like to go through fixed number of iterations of improving the guess. The reasons may not be as strange as you may like to believe. Imagine finding squareroot of very small numbers, even smaller than the limit of accuracy, 0.001 specified in our program. So we have the following version of our squareroot program.

```
input x
if x > 0
   then
       g = x/2
       for i = 1 to 10 do
             g = (g + x/g)/2
       endfor
       print x, g
   else
       print "Invalid input"
endif
```

Did you notice that step is missing in the for _ endfor structure? Yes, for obvious reasons. Most often the for _ endfor structure is used for normal counting from start to finish with increment of 1. So as a matter of convenience we do not require to specify any step if it is a normal step of 1.

This loop structure is so famous that it is available in all languages, structured or not. As usual, key words provided may be different. The Microsoft Quick BASIC calls it for _ next, and optionally provides for specification of control variable after next. Many other BASICs insist on mention of the control variable after next.

We have discussed program structures quite elaborately. Let us turn our attention to data structures that hold our values. So far we have been dealing with simple variables that hold only one value of desired type. So we have integer variable, floating-point variable, and string variable holding only one value of corresponding type at any moment. Can we have data structures that are capable of holding more than one value? Programming languages do offer complex data structures required for advanced programming. We shall discuss one of them.

Array data structure

Syntax: <u>var</u> (subscripts)

We can declare that a variable is required to hold more values of which each can be referred to by using corresponding subscript. Such a data structure is called an array and variable representing array is known as subscripted variable. They are normally declared in a dimension statement. In the simplest case array has only one dimension representing a sequence of values. Any of the elements in the sequence may be identified by an index. For example, consider an array of 10 values. The array will be declared by using a dimension statement.

i	A(i)
0	5.15
1	3.75
2	6.95
3	4.55
4	2.75
5	1.85
6	9.95
7	4.35
8	1.50
9	7.45

dimension A (9)
where A is the variable name and 9 refers
to maximum value of index we intend to use.
This array could be easily filled using
  tatements like

```
for i = 0 to 9 do
     input A (i)
endfor
```

In the example element A (3) has a value 4.55, A (7) is 4.35 and so on. The subscripted elements may be manipulated just like simple variables. They especially go hand-in-hand with control variable of for _ endfor structure as can be seen in above example, where one statement, input A (i) forming body of a for _ endfor loop is capable of inputting values for all the elements.

Arrays can be more complex than a sequence. We can visualise a two-dimensiional arrangement where elements are arranged in rows and columns, where individual element is identified by two subscripts, one referring to row and the other to the column. The situation is presented in the following example.

	0	1	2	3
i				
0	17	23	9	13
1	33	51	18	19
2	41	35	49	11
3	73	29	14	47
4	95	63	77	29

Relevant program segment would be
```
dimension A (4,3)
for i = 0 to 4 do
   for j = 0 to 3 do
      input A (i,j)
   endfor
endfor
```

In the example, A (3,2) is 14. We could add a third dimension with one more subscript and so on. The Microsoft Quick BASIC would allow you to go up to sixty three dimensions! Normally, you would not have occasions to go for more than two dimensions. On each dimension, the corresponding subscript may range from 0 to 32767. The maximum value each subscript will take is required to be declared in what all BASICs call a DIM statement. Although most of them do condone certain amount of laziness in explicit declaration (e.g arrays with subscript value less than 10), you are strongly advised to resist such temptation of non-declaration. In fact, most modern languages do insist on explicit declaration of even simple variables to avoid unpleasant surprises later while running the programme. We close our discussion on arrays with a reminder that arrays can be of any type; integer, floating-point, or string in the sense that each element can hold the value of that type. The Microsoft Quick BASIC identifies integer variables with special declaration character % as the last character in the identifier name [e.g. stock %, age % (60) denotes a simple integer variable and an integer array of 61 elements respectively]. It identifies string variables with $ as last character [e.g. z$, name$ (60)].

After elaborating on programming concepts like constants, variables, expressions, input, print and assignment statements, if_then_else_endif and loop structures, and array data structure let us develop some programs using them.

Let us develop a program to sort a sequence of numbers in ascending order. Too simple? Do not underestimate this problem. It has deserved a fat 800 pages book by eminent computer sceintist (See **Searchin and Sorting** by Donald Knuth). Also, more than 60 per cent of world computing power at any time is engaged in this activity! So we have,

```
Given a sequence of numbers in
any random order, print them
in ascending order.
```

Remember arranging cards during a card game? Pick them up one by one simultaneously arranging the picked cards in required order. Can we express it in terms of subproblems?

```
declare array to hold sequence of number
```

```
How many numbers?
```

```
Take one by one arranging the ones
taken so far in ascending order
```

```
Print the ordered sequence
```

Refining it further,

```
dimension A (100)
input n
for i = 1 to n do
      input A(i)
```

```
Put the just _ picked in its proper
position so that ones taken so far
are in ascending order
```

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```
endfor
for i = 1 to n do
   print A(i)
endfor
end
```

Let us refine the one in the box further. Ascending order means smallest number at the top and the highest at the bottom. For every number, the number above it cannot be bigger than that number. If that is the case, our number can pull down the bigger number to move up and continue its ascent till number above it is not bigger than it, or it has itself reached the top. Moral of the story is, everybody rises to one's level of incompetence! Expressing it step by step and polishing it up,

Informally	Polished one
where am I? at the bottom	k = i
while I am not on top and a bigger one is above	while k > 1 AND A(k) < A(k−1) do

pull it down, I take that position

and so on

```
┌──────────────────┐
│      x = A(k)     │
│   A(k) = A(k−1)   │
│   A(k−1) = x      │
└──────────────────┘
         k = k−1
```

```
endwhile
```

The boxed statements above achieve famous swapping of two elements A(k) and A(k-1). Try doing it without using an intermediate variable x. You cannot do it without losing one of the values in the process! The swapping is so famous that the Microsoft QuickBASIC provides a swap statement to express it!

Putting it all together,

```
dimension A(100)
input n
if n <= 100
   then
      for i = 1 to n do
         input A(i)
         k = i
         while k >1 AND A(k) < A(k−1) do
            x = A(k)
            A(k) = A(k−1)
            A(k−1) = x
            k = k−1
         endwhile
      endfor
      for i = 1 to n do
         print A(i)
      endfor
   else
      print "Too many numbers"
   endif
end
```

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Note little things like making sure that we do not cross self-imposed limits on number of elements in dimension statement. During the process of stepwise refinement we do not get digressed by such matters of details. After we are through with the development of main body of logic we can always insert it in some conditional structure. This also underscores importance of viewing programs as collection of bodies of statements snugly fitting in appropriate program structures, rather than sequence of statements to be navigated through GOTOs. This collection of bodies may be developed some what independent of each other, even by different individuals, and even as independent subprograms to be called from different parts of the program. That is the subject matter we are going to discuss next.

16.6 SUBPROGRAMS

Considering the two programs that we have already developed, would you agree that they are quite general purpose in nature? No wonder that squareroot program is generally available as standard library function in almost all languages. Many operating systems do provide 'sort' as an utility. There are many such problems that are required to be solved as subproblems by different programs, or even by a given program at several places within the program. For example, it is quite possible that we need to handle two or more arrays and we need all of them sorted in ascending order. We may obviously reproduce the relevant body of statements suitably modified to suit the local conditions wherever it is required. But can this reinventing of wheel be avoided? Yes, the answer is subprograms which are essentially slave-programs that can be invoked or called upon to do specific tasks by any part of main program or other subprograms. There are two kinds of subprograms, one whose main purpose in life is to have one value apart from any other side effects one may entrust to such subprogram, and the other kind are those whose preoccupation is the side effects only. Implication is that former may be used as operands in expressions, because they are equivalent to a simple variable or element of an array as far as having a value of some type is concerned. The subprograms with responsibility of having a value so that they can be used as operands in expressions are called functions. Other subprograms meant only for side effects are called procedures or subroutines. Note that something more is expected from functions than procedures, though our focus on one value of function in contrast with procedures, may give us a different feeling. There is some amount of redundancy in concept of procedures, there is no reason why we cannot ignore value of a function and enjoy only the side effects. The language C, in fact does just that. In language C, everything including the main program itself is a function! We shall however respect the time honoured convention of treating functions and procedures as distinct.

Function structure:

Syntax: function _name_ (_argument list_)

```
+----------------------------------------+
|        Body of statements              |
|        including those                 |
|        assigning value to              |
|        function                        |
+----------------------------------------+
```
endfunction

The function _ endfunction structure has three components. The name identifies the function and is normally governed by syntax rules of variable names or identifiers. The function is invoked by using the name just as variables in expressions. The argument list consist of parameters that are passed on to the function to participate in the computation. Body of statement is just like such a thing in any other structure with some subtle differences. Somehow we should be able to assign that one value which the function is expected to return to the expression invoking it. We shall do it as in Microsoft Quick BASIC using assignment statement. Some languages do it by enclosing the value or expression in a return statement. Other issue is of sharing of data beyond what is communicated through the argument list, between main program and subprograms, both the functions and the procedures. Some languages allow explicit sharing by declaring some variable to be common or external, all other variables being considered as local to the subprograms, distinctly different from identifiers with same name in the main or other subprograms. Other languages like Microsoft QuickBASIC, consider all identifiers as global unless explicitly declared as local by using static kind of a statement. We shall close the discussion on function after giving BASIC syntax for it. In BASICs like Microsoft Quick BASIC, where multi-line function definitions are allowed, the syntax would be,

    DEF FNname (argument list)

    STATIC list of local variables

    | _Body of statements including |
    | FNname = (expression) |
    | and, possibly |
    | EXIT DEF |

    END DEF

Single line function definition in such languages would be a straight forward.

    DEF FNname (argument list) = (expression)

Procedure Structure:

    Syntax: procedure name (argument list).
    | Body of statements |
    endprocedure

There is nothing more that we can discuss about procedures as we have discussed the related issues like sharing of data among programs, local and globally shared variables in the context of functions. We shall only discuss their form in languages like BASICs. Unstructured BASICs do not normally provide independent procedures in their full form. Parts of the program may be visited using GOSUBs to be RETURNed on encountering such a statement. There is no argument list, list, local variables and so on. the Microsoft QuickBASIC offers full-fledged procedure capability with the following syntax.

    SUB name (argument list) STATIC
        STATIC list of local variables
        SHARED list of main program
               varibales to be shared
        Body of statements possibly
        including EXIT SUB
    END SUB

Note the STATIC in SUB line as well as for declaration of local variables. Former says the procedure cannot be recursively called by itself. The latter meaning as local variables is the same as in function declaration. In addition, we have SHARED list of variables that were declared in main program but also to be shared in the procedure. The Microsoft Quick BASIC has somewhat different scheme for sharing of data between main program and the procedure compared to that with function. We can declare the COMMON list of variables in main program and procedures, matching in type possibly with different names. We can declare some as COMMON SHARED list of variables in the main program so that they can be referred by procedures by name without having to declare as COMMON or SHARED in the procedure. Third option is to declare them as SHARED list of variables as mentioned before. Note that variables used in procedures are independent of those used in the main program or other procedures unless they figure in COMMON SHARED list in main program or SHARED list in procedure. In case we want to use variables declared as COMMON SHARED in main program as local variables in procedures we have to declare them as STATIC in the procedures. While developing programs in structured English, we shall follow the same conventions as the Microsoft Quick BASIC for handling global and local variables in subprograms.

We shall illustrate use of subprogram by developing a program for advancing calendar by a day. The solution procedure will have to take care of limits on number of days in a month, leap years and so on. This will also give us an opportunity to explore multiple choice case _ endcase structure. We shall follow similar narrative style as in sorting program presenting informal and polished program side by side capturing process of program development.

Informally...	Polished program
Take given date	input d,m,y
if valid	if valid (d,m,y)
then	then
advance it by a day	call advday (d,m,y)
print the new date	print d,m,y
else	esle
print "Invalid date"	print "Invalid date"
	endif
	end

We have to develop two more subprograms, a function valid (d,m,y) and a procedure advday (d,m,y) for advancing the day. Please resist the temptation of writing a monolithic program where obvious subprogram possibilities are clearly visible.

Taking up advday further...	procedure advday (dd, mm, yy)
simple, just add 1 to day!	dd = dd + 1
oops! may be a mistake.	if NOT (valid (dd, mm, yy))
what if it was 31 August?	then
the next day would be 1 not 32	dd = 1
but you should advance month too	call advmonth (dd, mm, yy)
	endif
	endprocedure

Taking up advmonth further...	procedure advmonth (d,m,y)
as before, advance month by 1	m = m + 1
think of worst, 31 Dec.	if NOT (valid (d,m,y))
next month would be 1 rather	then
than 12, the year would advance	m = 1
too	y = y + 1
	endif
	endprocedure

We have refined everything except the function for ascertaining validity of a date. Note that valid (d,m,y) has not only been used in the main program but also has been invoked in every procedure to check whether advancing day or month has made the date invalid. To check validity we consider various cases of day, month or year values being valid or not. We naturally use a case _ endcase structure which is much simpler than its big brother if _ then _ elseif _ .. _ else _ endif when all the conditional expressions consist of only one variable participating in equality testing.

Taking up valid ..	function valid (xd, xm, xy)
but is it obviously	if (xd < 1 OR xy < 0)
invalid?	then
	valid = 0
how about day & month	else
check case by case	case xm of
any of the 31-day months?	1,3,5,7,8,10,12
Note the use of relational	valid = (xd < = 31)
expression in assignment.	
any of the 30-day months?	4,6,9,11
	: valid = (xd < = 30)
is it February?	2 : valid = (xd < = 28 + leap (xy))
Remember to write leap function	
invalid month	: valid = 0
	endcase
	endif
	endfunction

How do we find out whether year is leap? If the year is divisible by 4 but not by 100 except by 400 then the year is considered to be leap. Thus 1988 is leap, but 1900 is not, however 2000 is leap. The Microsoft Quick BASIC gives a operator called MOD to compute remainder of an integer division. MOD has a prior· ·higher than addition or subtraction.

Lastly....	
To compute leap factor	function leap (yy)
divisible by 4?	if (yy MOD 4)
	then
No	leap = 0
divisible by 100?	elseif yy MOD 100 then
4 but not 100	leap = 1
divisible by 400?	elseif yy MOD 400 then

```
    100 but not 400                          leap = 0
                                    else
     by 400                                  leap = 1
                                    endif
                                endfunction
```

We end the discussion on calendar advancing program by making some observations on Microsoft Quick BASIC implementation. Note that all the function definitions must precede their use. Also note that case   endcase structure as used by us would be translated as

```
    SELECT CASE xm
        CASE 1, 3, 5, 7, 8, 10, 12
            invalid = (xd < = 31)
        CASE 4,6,9,11
            invalid = (xd < = 30)
        CASE 2
            invalid = (xd < = 28 + fnleap (xy))
        CASE ELSE
            invalid = 0
        END SELECT
```

Note that the function names have been presumed to have been changed to begin with fn as required by the language.

16.7 MISCELLANEOUS TOPICS

String Handling:

So far we have been considering mainly the numeric problems. But the concepts covered so far are equally applicable to textual problems involving string type of values. The body of statements in various program structures would consist of string expressions performing concatenation (simply joining using + operator), and comparison of strings. Languages provide rich set of functions for string handling. Prominent among the functions available in the Microsoft Quick BASIC are

LEN (x$)	Returning number of characters in value of x$
LEFT $ (x$,n)	REturning a string consisting of leftmost n characters in value of x$
RIGHT $ (x$, n)	Close cousin of above, returning a string of rightmost n characters in value of x$
MID $(x$,n,m)	Middle cousin, returning a string of m characters from value of x$ beginning with nth character
INSTR(n,x$, y$)	Detective function to search whether value of y$ is occurring as substring in x$ beginning with nth character. If found, returns the position indicating start of y$, returns O otherwise.

To understand the above functions, the string value of x$ of length 1 = LEN(x$), may be visualised to be consisting of three parts, namely, LEFT$ (x$,n) of first n characters, MID$(x$, n + 1,m) being the next m characters, and RIGHT$ (x$, 1-n-m) of remaining tail-enders of length LEN (x$)-n-m. Any of these parts may be the substring of our interest. and INSTR (n,x$,y$) locates that for us.

Let us see string handling in action through couple of programs. First we shall develop a program to check whether a given word is a palindrome that reads the same backward as forward (e.g. madam, rotor, malayalam).

Informally..	polishing it up...
The given word	input w$
Start looking it backwards	r$ = " "
taking each character	for j = LEN (w$) to 1 step - 1 do
build reverse word	r$ = r$ + MID$ (w$. j. 1)
completely	endfor
Comparing the two	if w$ = r$
Print appropriate	then
message	print w$ "is a palindrome"
	else
	print w$, "is not a palindrome"
	endif

Alternatively, the for _ endfor part could also be equivalently written as

looking from front	for j = 1 to LEN (s$) do
and appending every new	r$ = MID$ (w$, j, 1) + r$
character in front	endfor

Next let us write a general letter to x x x so that we can later personalise it to any particular name where all the occurrences of x x x will be rep'aced by the particular name. So,

Take down the letter	L$ = " "
Initially it is blank	repeat
Take it line by line	line input p$
unless current line is	if LEFT$ (p$,3) = "ZZZ" then exit
a nonsense "ZZZZ.."	L$ = L$ + p$
keep appending it	endrepeat
who is the person?	input X$
Replace by x x x him/her	repeat
x x x still there?	n = INSTR (O, L$, 'x x x")
unless not there	if n = 0 then exit
	t = LEN (L$)
replace	L$ = LEFT$ (L$, n-1) + x$ + RIGHT$
	(L$, 1-n-2)
	endrepeat

Note the use of line input for inputting a line. This is different from plain input in the sense that entire line with all its characters (spaces, commas, quotes, even return/line feed) are considered as part o' string. Languages do provide such statements. The Microsoft Quick BASIC calls it

line input whereas other BASICs call it inputline or even LINPUT. Also, note a smart trick of "ZZZZ..." to indicate that we are through with our letter.

Note also the cut and paste kind of operation in L$ = LEFT$(L$, n - 1) + x$ + RIGHT$ (). t-n-2), where unwanted "x x x" has been surgically removed by isolating LEFT$ (L$, n-1) and RIGHT (L$, t-n-2) around it and pasting x$ in its place.
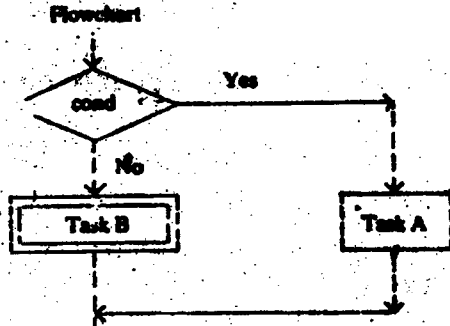
Program Structure

```
if (cond.)
    then

        [ Task A ]

    else

        [ Task B ]

endif

if cond 1
    then
        Task A
    elseif cond 2 then
            Task B

        else
            Task Z
endif

repeat

            Task A

until (cond).


while (cond) do
        Task A
endwhile


for var = start to finish step incr do
        Task A
endfor
```
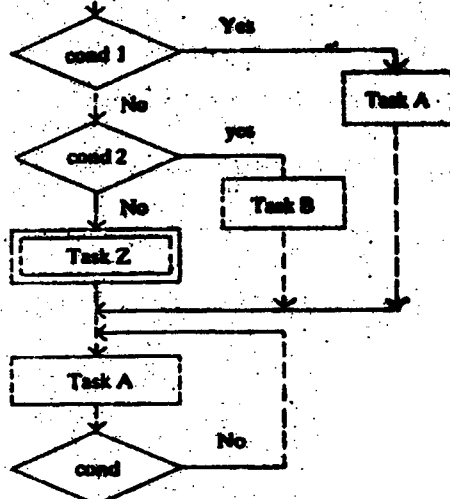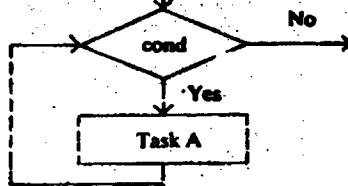

Flowchart

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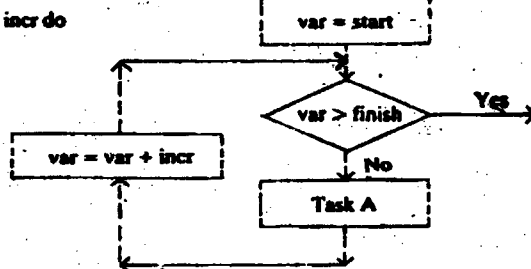
Why not Flowcharts?

With this we conclude our discussion on programming concepts. Some of you might be wondering why we have not discussed flowcharts. Our dislike for flowcharts is mainly due to the fact that they emphasise navigational view of program development just as GOTOs in programs. Moreover, flowcharts of even moderately complex programs tend to become very cluttered. They merely turn out to be documentation aids rather than program development tools. On the other hand, the structured approach followed by us not only helps in development through stepwise refinement but also makes the program self-documenting through proper indenting. Such programs may be viewed as textual flowcharts. However, if you still insist on knowing about them, we have given above the flowcharts for various program structures so that you can build the flowchart for your program if you like.

Note that flowchart for the for _ endfor loop structure is for positive incr value. In case the incr is negative value, then condition being tested would be var < finish.

Apart from being cluttered and inherently navigational, the flowcharts also make ambiguous use of decision symbol for single and multiple conditional branching as well as different loop structures. Therefore we strongly suggest that you do not use them for program development or documentation purposes. We also suggest that you develop program in structured English and then translate them into the implementation language of your choice. If the implementation language is very close to our structured English, say, differing only in choice of key words as in case of the Microsoft QuickBASIC then you may conveniently use its key words for program structures directly, but still following the stepwise refinement process of program development. If your implementation language is relatively unstructured, then we suggest that you develop a standard translation table for translation of each program structure that can be used to translate programs developed in structured English into your implementation language.

16.8 SUMMARY

In this unit we have explained the basics of computer programming. It follows the gradual exposure to writing programmes in higher language and logically matched it with the structured English. In this unit we have also exposed you to a number of programmes used commonly and simultaneously explained their processing logic. Further towards the end we have referred briefly to development of flowcharts.

UNIT 17 PROGRAMMING LANGUAGES: COBOL AND ITS APPLICATIONS

Objectives

After going through this unit you should able to:

● understand the basic features of COBOL

● understand and develop familiarity with the different steps involved in writing programmes in COBOL

● start writing simple (elementary) programmes in COBOL

Structure

17.1 Introduction

17.2 Business Data Processing

17.3 Brief overview of COBOL

17.4 Structure of COBOL Programmes

17.5 COBOL Implementation of a Simple Data Processing Problem

17.6 Other features of COBOL

17.7 Summary

17.8 Self-assessment Exercises

17.9 Further Readings

17.1 INTRODUCTION

COBOL is a computer language designed for use in business data processing. COBOL stands for Common Business Oriented Language. Historically, the language was first conceived at a Pentagon meeting in 1959. At that meeting representatives from government, business users and computer manufacturers decided that it was feasible to proceed with development of a higher level language that would answer the needs of business data processing. However, it was not until August 1968 that a standard version of the language was approved by what is now called the American National Standards Institute (ANSI). This standard version, ANSI COBOL, was again revised in 1974 and has now been implemented by all major manufacturers. In this note we present the features of the commonly used elements of ANSI COBOL and some applications of this language.

17.2 BUSINESS DATA PROCESSING

Business data processing involves recording, manipulation and analysis of data and preparation of useful outputs and reports. In general business data processing problems are characterised by relatively simple algorithms coupled with high-volume input-output. Financial accounting, Sales invoicing, Inventory control are some examples of data processing.

In order to accomplish these tasks through a computer system we need facilities in the programming language to describe the structure of data files, have language statements to create, manipulate and analyse the data in the files, and to present the processed information in the form of reports.

In addition to these, documentation of programs is an important requirement of business applications which are dynamic. Therefore a business data processing language should have facilities to write the programs in a manner that can be understood and modified if necessary. In the subsequent sections we see how COBOL supports these features.

17.3 BRIEF OVERVIEW OF COBOL

Since input-output is a prime concern in business application programs, the COBOL design emphasises features for the specification of properties and structure of input-output files. COBOL supports hierarchical data structures building from elementary data items to group data items and records. This implies that the programmer can define convenient data structures and perform operations on those structures using the COBOL statements. These features enable the programmer to create data on computer, manipulate and analyse the data and also prepare reports in the desired form with little effort.

Another important language characteristic is the English-like syntax of the language statements. The computer programs written in this language are substantially self-documenting. Self-documentation is a feature of a language that allows the reader of a program to understand its function and follow its processing steps. COBOL instructions are English-like, and the programmer with little effort can develop self-documenting programs

17.4 STRUCTURE OF COBOL PROGRAMS

COBOL programs have to be organised into four divisions. This organisation is largely a result of two design goals:
i)   Separate machine-dependent from machine-independent program elements.
ii) Separate data descriptions from algorithm descriptions so that each might be modifiable without affecting the other.

The result is the following program structure:
1. **Identification Division**   Giving program identification details.
2. **Environment Division**   Giving the details of computer environment in which the program will be executed.
3. **Data Division**   In which the structural details of data files and variables used the program are described.
4. **Procedure Division**   In which the processing details are described through COBOL statements.

COBOL programs should be written according to a special structure which is organised into a hierarchy of parts as described below:

A character is the lowest form in the program structure.

word is made of one or more characters.

clause consists of characters and words and is used to specify an attribute of an entry.

statement is syntactically valid combination of words and characters written in the ROCEDURE DIVISION and beginning with a verb.

. sentence is a sequence of one or more statements, the last of which is terminated by a period followed by a space.

A paragrapn consists of one or more sentences.

A section consists of one or more pragraphs.

A division consists of one or more praragraphs or sections.

very program consists of four divisions in the following order: IDENTIFICATION DIVISION, ENVIRONMENT DIVISION, DATA DIVISION, and PROCEDURE DIVISION.

We illustrate these features with few examples from data processing environment.

17.5 COBOL IMPLEMENTATION OF A SIMPLE DATA PROCESSING PROBLEM

Consider a data processing problem in which we are required to prepare a statement giving the value of items in stock by processing records having data on stock quantities and unit prices in addition to the code and description of items in stock.

The layout of data record in the item-stock file is given below:

Item code			Description	Stock Quantity	Price
MG	SG	SN			
2	2	2	24	4	6: 4+2
Numeric Integer			Alphanumeric	Numeric Integer	Numeric non-integer

The Item code is a group data field consisting of main group (MG), sub group (SG) and serial number (SN): each being a two digit numeric integer. Description is 24 characters long alphanumeric data field. Stock quantity is four digit numeric integer data field. Finally the price per unit is a six digit long numeric non-integer field with four integer digits and two decimal igits.

The organisation of COBOL program for this problem would be as follows:

Identification Details

The identification details such as program identification, author, installation, date of writing, and date of compilation will have to be presented in the IDENTIFICATION SECTION of the ogram as presented in the following segment of the program:

```
DENTIFICATION DIVISION.
PROGRAM--ID.        STKVLN.
AUTHOR.             IGNOU.
INSTALLATION.       IGNOUCC, DELHI
DATE--WRITTEN.      01/06/87.
DATE--COMPILED.     TODAY.
```

Environment Details

Details about the computing environment such as configuration, Input and Output devices assignment of files to devices will have to be described in the ENVIRONMENT DIVISION of the program in CONFIGURATION and INPUT--OUTPUT sections respectively. The ENVIRONMENT DIVISION for our stock valuation program would have the description of computing environment and the statements assigning the stock master file and report file to the devices supported by the system as shown below:

```
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-- COMPUTER. IBMPC.
OBJECT--COMPUTER. IBMPC.
INPUT--OUTPUT SECTION.
FILE--CONTROL.
        SELECT STK--MASTER ASSIGN TO DISK
            ORGANIZATION IS LINE SEQUENTIAL.
        SELECT STK--VAL--RPT ASSIGN TO DISK.
            ORGANIZATION IS LINE SEQUENTIAL.
```

These statements convey that the program will be compiled on IBMPC computer, to obtain object code that can be used on IBMPC for execution. The files used will be STK--MASTER and STK--VAL--RPT, both are sequential and assigned the device disk implying that both these are disk files. Notice that such assignment is done in the FILE--CONTROL paragraph of the section.

The sections and paragraphs used so far are standard and have specific semantics as illustrated above. In the forthcoming segments of code also we will be encountering such standard paragraph and section names:

Data Description

Structures of the files and other data variables used in the program will have to be described in the DATA DIVISION. There will have to be described separately in two standard sections namely FILE SECTION and WORKING--STORAGE SECTION.The FILE SECTION should be used to describe structural details of all the files referenced in the program. WORKING--STORAGE SECTION will have to be used for describing the details of temporary variables and record structures.

In our example the FILE SECTION will have the descriptions of STK--MASTER and STK--VAL--RPT files.

The data elements used to hold value of stock, total value, names of files, titles etc. will be described in the WORKING-STORAGE SECTION. Similarly record structures to compose title lines, report lines and footer lines etc., will also be described in this section.

DATA DIVISION for our stock valuation program is given below:

```
DATA DIVISION.
FILE SECTION
FD STK-MASTER
        LABEL RECORDS ARE STANDARD
        VALUE OF FILE-ID IS STKMST-NAME
        DATA RECORD IS STOCK-REC.
01 STOCK-REC.
        02 ITEM-CODE.
        05 MAIN-GR            PIC 99.
        05 SUB-GR             PIC 99.
        05 SR-NO              PIC 99.
        02 DSCRIPTION         PIC X(24).
        02 STK-QTY            PIC 9(4).
        PRICE-PU              PIC 9(4) V 99.
FD STK-VAL-RPT
        LABEL RECORDS ARE STANDARD
        VALUE OF FILE-ID IS SV-RPT-NAME
        DATA RECORD IS REPORT-REC.
01 REPORT-REC                 PIC X(70)
WORKING-STORAGE SECTION.
01 REPORT-LINE.
        02 FILLER             PIC X(3) VALUE SPACES.
        02 R-ITEM-CODE        PIC 9(6).
        02 FILLER             PIC X(3) VALUE SPACES.
        02 R-DESCRIPTION      PIC X(24).
        02 FILLER             PIC X(3) VALUE SPACES.
        02 R-STK-QTY          PIC Z,ZZ9.
        02 FILLER             PIC X(3) VALUE SPACES.
        02 R-PRICE-PU         PIC ZZ9.99.
        02 FILLER             PIC X(3) VALUE SPACES.
        02 R-VALUE            PIC ZZ,ZZ,ZZ9.99.
01 HEADER-REC.
        02 FILLER             PIC X VALUE SPACES.
        02 FILLER             PIC X(9) VALUE "ITEM CODE".
        02 FILLER             PIC XX VALUE SPACES.
        02 FILLER             PIC X(16) VALUE "ITEM DESCRIPTION".
        02 FILLER             PIC X(6) VALUE SPACES.
        02 FILLER             PIC X(8) VALUE "QUANTITY".
        02 FILLER             PIC XX VALUE SPACES.
        02 FILLER             PIC X(7) VALUE "PRICE".
        02 FILLER             PIC X(10) VALUE SPACES.
        02 FILLER             PIC X(5) VALUE "VALUE".
```

```
   01 STKMS1--.  .ME          PIC X(15).
   0'. SV--RPT--NAME          PIC X(15).
   01 END--OF--DATA           PIC X(3).
   0 L DASH--LINE             PIC X(70) VALUE ALL "--".
   0 L TOTAL-VALUE            PIC 9(7) V99 VALUE ZERO.
   0 L ITEM--VALUE            PIC 9(7) V99.
   01 R--TOTAL--REC.
        02 FILLER             PIC X(11) VALUE "TOTAL VALUE".
        02 FILLER             PIC X(41) VALUE SPACES.
        02 R--TOTAL-VALUE  PIC Z,ZZ,ZZ,ZZ9.99.
```

This segment of the program which presents the structural details of files and data variables requires explanations of several conventions used.

File Description: Starting with the FILE SECTION, the first entry used is FD, which stands for File Description. Through this entry programmer conveys whether the file is on auxiliary storage devices like magnetic tapes or disks with standard label records or . is on terminal devices like card reader or line printer which do not have label records. In addition to this he also specifies the name of the variable which holds the file name through FILE-ID clause. The name assigned to the data record is also specified in this entry through DATA RECORD clause For example the STK--MASTER file is a disk file with standard label records; its data record is assigned the name STOCK--REC. Although the file is referenced with the name STK--MASTER in the procedure development, the variable STKMST--NAME holds the actual name of the file containing the stock data to be processed.

Record description: Just below the FD entry the programme should present the structural details of the data record as a hierarchical data structure using the level numbers and names of data fields. The characteristics of the data fields should also be specified for the elementary data elements. For example the STK--RECORD is composed of ITEM--CODE, DESCRIPTION, STK--QTY and PRICE--PU in the order described. These are the names which we have chosen to call the data fields presented in the record layout. It may be noticed that a level number 01 is assigned to STOCK-REC and the other data fields described above are assigned the higher number 02 since they are components of (hierarchically lower to) STOCK--REC. The same logic is applied in assigning the level numbers to sub fields of any of these data fields. For example the sub fields of ITEM--CODE, i.e. MAIN--GR, SUB--GR, and SR--NO are assigned the level numbers 05. It may also be noticed that the data elements like STOCK--REC and ITEM--CODE did not contain the description of their type characteristics since they are not elementary data items.

Description of Elementary Data Items: The elementary data items i.e., items which do not have further sub components should have description of their type and size etc. through PICTURE clause. The picture clause includes the letters PICTURE or PIC followed by the description of the field. .

The field description includes the information as whether the field is numeric, alphabetic. or alphanumeric; whether it is computational or display; whether it contains editing characters whether it contains a decimal point; and whether a numeric field can contain a negative value etc. Some examples of field descriptions are presented below:

Picture character	Purpose	Example
9	represent the presence of numerical digit	99 9(6) or 999999
V	indicate the position of assumed decimal point	99 V99 9(4) V99
P	indicate the position of decimal point in cases in which decimal point is not within the number	99PPPV VPP9999
S	to designate a numeric field which is assigned.	S999V99 S9(5)V99
X	to denote the positions of alphanumeric characters in the field.	XXXX or X(4)
A	to indicate the presence of alphabatic characters or blanks in the field.	AAAA or A(4)

Editing Symbols: Edit symbols are used in the picture description to present the data values in a convenient form in the output. The data-names whose picture description includes edit symbols cannot be used in arithmetic operations since such fields contain alphanumeric characters rather than simple numeric characters. Following are some picture characters used as edit symbols:

Picture character	Purpose	Example
$	to indicate where $ sign should appear in the output. When floated (repeated more than once) indicates its insertion left to the most significant digit of field.	$999 $$$$ $$$$.$$ SSS.99
	indicate the position where " " should be inserted in the data field	9,999.99 $99,999,99
	indicates the position of the decimal point in the data field.	999.99 $$,$$$.$$
Z	replace leading zeroes with balnks	Z99 ZZ,ZZZ.ZZ
CR	insert chars 'CR' to the right of number if it is negative	$$,$$$.99CR 999.99CR
DB	insert chars 'DB' to the right of number, if it is negative	ZZ,ZZZ.ZZDB 9999.99DB
*	replace leading zeroes by '*' ('*' in this format is known as cheque protection symbol)	$ x x.x.x.99

to have the sign of the number		+ 999.99
included either to left or right		999.99+
can be used as floating symbol		+ + + + . + +
to have the sign included only if		-999.99
the number is negative else blank		999.99-
can be used as floating symbol		- - - - . - -
B	blank insertion	ABABX(8)
0	zero insertion	9990000
	stroke insertion	99/99/99

Depending on the storage and output requirements of the application being programmed, one can build the desired picture strings for various data fields using the above described symbols.

Naming the Data Elements: Throughout the abvove discussion, we have identified the data elements with some data-names. The data-names can be coined at the discretion of the programmer, except that there are certain rules that must be followed:

A data-name can be up to 30 characters and can include alphabetic characters, numeric characters, and hyphens. At least one character must be alphabetic. A hyphen if used, must be embedded; that is it cannot be the first or last character of the data-name. Blanks cannot be included in the data-names. Within the above rules the programmer may use any data-name, with the exception of the COBOL reserved words.

Certain data fields which are not required to be referenced by any specific name may be assigned the COBOL standard name FILLER. Any number of FILLERs can be used in the DATA DIVISION.

Assigning Initial Values: The description of data element may also include the VALUE clause to initial values to these data elements.

Examples:

```
01   DASH--LINE          PIC X(70) VALUE ALL "--".
01   TOTAL--VALUE        PIC 9(7) V99 VALUE ZERO.
01   HEADER--REC.
     02   FILLER         PIC X VALUE SPACES.
     02   FILLER         PIC X(8) VALUE "ITEMCODE
```

Processing Details

In a COBOL program, the processing instructions have to be presented in its PROCEDURE DIVISION. In the example of stock valuation, the processing steps would be:

i) Prompting the user for the names of stock data file and report file, accepting the user supplied names and opening these files to perform input and output operations respectively.

ii) Writing the title lines on the output report.

iii) Reading a record from stock data file, computing the value of the stock and writing a record on the output file giving out the item details, its stock and computed value.

v) Performing the step (iii), repeatedly, till we reach the end of file on the stock data file

Writing out the total values and closing lines on the output file and closing the files.

These steps expressed in COBOL would be as follows:

```
PROCEDURE DIVISION.
START-PARA.
    DISPLAY "ENTER THE NAME OF STOCK DATA FILE".
    ACCEPT STKMST-NAME.
    DISPLAY "ENTER THE NAME OF OUTPUT FILE".
    ACCEPT SV-RPT-NAME.
    OPEN INPUT STK-MASTER.
        OUTPUT STK-VAL-RPT.
    MOVE "NO" TO END-OF-DATA.

PROCESS-PARA
    WRITE REPORT-REC FROM DASH-LINE.
    WRITE REPORT-REC FROM HEADER-REC.
    WRITE REPORT-REC FROM DASH-LINE.
    PERFORM READ-STOCK-REC.
    PERFORM PROCESS-RECORD UNTIL END-OF-DATA = "YES".
    WRITE REPORT-REC FROM DASH-LINE.
    MOVE TOTAL-VALUE TO R-TOTAL-VALUE
    WRITE REPORT-REC FROM R-TOTAL-REC.
    WRITE REPORT-REC FROM DASH-LINE.
    CLOSE STK-MASTER STK-VAL-RPT.
    STOP RUN.

REAL-STOCK-REC.
    READ STK-MASTER AT END MOVE "YES" TO END-OF-DATA.
PROCESS-RECORD.
    MOVE ITEM-CODE TO R-ITEM-CODE.
    MOVE DESCRIPTION TO R-DESCRIPTION.
    MOVE STK QTY TO R-STK-QTY.
    MOVE PRICE-PU TO R-PRICE-PU.
    MULTIPLY STK-QTY BY PRICE-PU GIVING ITEM-VALUE.
    MOVE ITEM-VALUE TO R-VALUE.
    ADD ITEM-VALUE TO TOTAL-VALUE.
    WRITE REPORT-REC FROM REPORT-LINE.
    PERFORM READ-STOCK-REC.
```

In this segment of the program which consisted of PROCEDURE DIVISION, we have used number of COBOL statements and sentences involving appropriate verbs to convey the operation to be performed on the data elements or records of the files referenced. The COBOL verbs are more English like and the operation to be performed can be derived from the literary meaning of the verbs used in the sentences.

Following are some COBOL verbs alongwith their meanings.

COBOL verb	Meaning

1. **Input-ouput verbs**

OPEN — Open the file for the specified operation (INPUT or OUTPUT)

CLOSE — Close the specified file. After this operation the READ or WRITE operations cannot be performed on the referenced file.

READ — Read a record from the referenced file.

WRITE — Write out the referenced record on to its file.

ACCEPT — Accept (read) data from user terminal.

DISPLAY — Display (write) the data values on the user terminal.

2. **Data Movement verb:**

MOVE — Move the data from one oata element to another. The result of move operation depends on the types and sizes of sending and receiving fields. The group move or move into a alphabetic or alphanumeric data field, aligns the values left justified. Moving a numeric integer to another numeric integer field results in right justification. Movement of numeric non-integer is done with decimal alignment. Movement of numbers to edited fields is guided by the edit symbols used in the picture description of the receiving fields. If the receiving field is short, the result will be truncated appropriately.

Example:

MOVE ITEM-VALUE TO R-VALUE moves the value 300000 of ITEM-VALUE as 30,000-00 into R-VALUE because of the numeric edited picture ZZ,ZZ,ZZ99.99 of R-VALUE and picture 9(7) V99 of ITEM-VALUE.

3. **Procedure control verb:**

PERFORM — Branch to the indicated paragraph, execute the instruction(s) in the paragraph, and then return to the statement immediately following the PERFORM instruction.

4. Arithmetic verbs:

ADD
SUBTRACT
MULTIPLY
DIVIDE

Execute the specified arithmetic operation.

In/our stock valuation program in the START-PARA we have statements which first prompt for the names of the files using the DISPLAY verb. User responses to these prompts are accepted into appropriate variables using ACCEPT verb. The stock master file is opened for input thereby permitting only reading operations on the STK-MASTER file. The stock valuation report, STK-VAL-RPT, is opened for output so that a new file is created and records are appended to it as we execute statements involving WRITE verb on this file. The variable END-OF-DATA is initialised with a value "NO", in this paragraph.

The next paragraph of the procedure writes the title lines on the report file. It then executes a paragraph which reads a record from STK-MASTER file. The paragraph PROCESS-RECORD, moves the data fields of the current stock record into corresponding edited fields in the report record, computes item value by multiplying stock quantity with price per unit, builds up the total stock value, writes report record to the output file and reads in the next stock record. This paragraph is executed repeatedly until end-of-data condition is encountered on the stock master file. Such condition is setup in the READ-STOCK-REC paragraph, by moving "YES" to the variable END-OF-DATA on encountering the end of file status on STK-MASTER file.

After performing (executing) the PROCESS-RECORD para until an end of data condition is encountered, the footer lines including the one giving the total value of items in the stock are moved to the output file. The files are then closed using CLOSE verb and the program execution is terminated using STOP RUN statement.

It may be noticed that the PROCEDURE DIVISION statements are almost English-like. With meaningful names chosen for paragraphs and data elements (records and fields) a procedure division can be programmed to be self explanatory.

Sample Input and Output Files

We present below a sample STK-MASTER file and the corresponding STK-VAL-RPT file generated by executing the COBOL program illustrated above:

LISTING OF STK-MASTER FILE

```
123456TUBE LIGHT 40W                          10003000
023451FILAMENT BULB 60W                       02000500
```

LISTING OF STK-VAL-RPT FILE CREATED BY PROGRAM

ITEM CODE	DESCRIPTION	QUANTITY	PRICE	VALUE
123456	TUBE LIGHT 40W	1,000	30-00	30,000-00
023451	FILAMENT BULB 60W	200	5-00	1,000-00
TOTAL VALUE				31,000-00

17.6 OTHER FEATURES OF COBOL

Through the example of stock valuation we have introduced a number of features of COBOL. The features not covered so far include table handling, string manipulation, advanced sequence controls, advanced file structures, report writer and screen handling.

Table Handling

COBOL permits the arrays to be used as elements of records. The language offers powerful table handling features which are described in the subsequent sections.

Description of Table Data Structures

The OCCURS clause can be used to declare a vector, individual elements of which may be an elementary data item or another record or array. For example to set up a table of sales values in say four zones, we would have the following data description:

```
01    SALES-TABLE.
          05 SALES-VALUE      OCCURS 4 TIMES      PIC 9(6) V99.
```

Through this description we define a record, SALES-TABLE which consists of the vector of four numeric non-integer data-elements with six integer digits and two decimal digits in size. Reference to these data elements can be made by using an appropriate subscript with the data-name SALES-VALUE. For example you want to refer to the sales value of third zone, you should make the reference as: SALES-VALUE (3).

We can also define a two dimensional table to store the sales values zone-wise and quarter-wise as given below:

```
01    SALES-TABLE.
      02    ZONE-SALES                OCCURS 4 TIMES.
              05   QTR-SALES          OCCURS 4 TIMES    .  PIC 9(6) V99.
```

The layout of SALES-TABLE would be as given below:
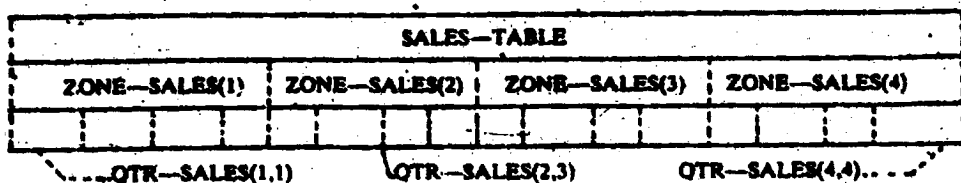
COBOL permits up to three levels of nesting of OCCURS, thereby allowing the use of up to three dimensional arrays.

COBOL also permits the use of mixed structures containing both records and arrays as presented in the example below.

```
01    EMPLOYEE-DATA.
          02    EMP-CODE          PIC 9(6).
          02    EMP-NAME          PIC X(30).
          02    EXPERIENCE OCCURS 10   TIMES
```

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```
03    ORGN-NAME    PIC X(20).
13    YEARS-SRVD   PIC 99V9.
03    LST-DSGN     PIC X(20).
03    LST-GR-SAL   PIC 9(5).
```

In this example we have the EMPLOYEE-DATA record consisting of the data fields EMP-CODE and EMP-NAME and an array EXPERIENCE of 10 records each consisting of the fields ORGN-NAME, YEARS-SRVD, LST-DSGN and LST-GR-SAL.

In this data structure, if we want to refer to LST-GR-SAL of the third experience record of an employee, we should address it as LST-GR-SAL(3). References to other data fields of EXPERIENCE will have to be made in a similar manner. The reference EXPERIENCE(5) addresses the fifth record of the EXPERIENCE table. This implies that operations such as MOVE treat all the four sub fields of the referenced record as one unit.

Operations on Table Data Structure

COBOL provides two powerful operations on tables. These are SEARCH and extended form of PERFORM.

Through SEARCH feature one can programme the searching operation on a data table with a single sentence. The following example illustrates SEARCH feature:

Consider a data processing task in which we read the data of about 300 items into a table. We are then required to find the description and price of item, given its code. Assume that the table is sorted on the item code order. Since the table will be searched by reference to the item code, the record description entry can be written in such a way as to indicate the fact that the table is sorted on item code in ascending order. Further record description be so written that reference to table entries can be made by use of a variant of subscript concept, called an index as follows.

```
01 . ITEM-TABLE
       02 ITEM-DATA OCCURS 300 TIMES
                       ASCENDING KEY IS ITEM-CODE
                       INDEXED BY IT-IX
           03    ITEM-CODE    PIC X(8).
           03    DESCRIPTION  PIC X(30).
           03    PRICE-PU     KPIC 9(4) V99.
```

Suppose RQ-ITEM is a field that contains a code for which we want to find the description and price-pu. The following PROCEDURE DIVISION statements perform the required task.

```
SEARCH ALL ITEM-DATA AT END PERFORM NOT-FOUND
           WHEN ITEM-CODE (IT-IX) = RQ-ITEM
           MOVE DESCRIPTION (IT-IX) TO RQ-DESCR
           MOVE PRICE-PU (IT-IX) TO RQ-PRICE
```

Other form of SEARCH enables searching an unsorted table. The same example with search into unsorted ITEM-TABLE would be as follows:

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DATA DIVISION entry:

```
01 ITEM-TABLE.
      02    ITEM-DATA OCCURS 300 TIMES INDEXED BY IT-IX.
            03    ITEM-CODE      PIC X(8).
            03    DESCRIPTION    PIC X(30).
            03    PRICE-PU       PIC 9(4) V99.
```

PROCEDURE DIVISION entry:

```
      SET IT-IX TO 1.
      SEARCH ITEM-DATA AT END PERFORM NOT-FOUND
             WHEN ITEM-CODE (IT-IX) = RQ-ITEM
             MOVE DESCRIPTION (IT-IX) TO RQ-DESCR
             MOVE PRICE-PU (IT-IX) TO RQ-PRICE.
```

The value of IT-IX is initialised to 1 by statement SET IT-IX TO 1. Since the table has not been sorted, a linear search will be performed beginning with the first entry of the table.

Sequence Control

In the PROCEDURE DIVISION each paragraph and section begins with a label which may be used as object of GOTO or PERFORM control transfer. Execution follows the physical statement sequence without regard to sentence, paragraph, or section boundaries unless a GOTO, PERFORM, or IF statement is used to explicitly transfer control. Paragraphs or sections may be used as simple subprogrammes, but control is also allowed to flow into the same paragraphs or sections in the normal sequence of execution.

A simple GOTO may transfer control to any paragraph or section label. A multiple branch using a list of labels and a computed subscript is also provided in COBOL.

An if_ then_ else is provided in COBOL using the syntax: If < condition> <statement sequence> ELSE < statement-sequence> The < condition > specified may be relational or boolean expression.

The PERFORM statement in COBOL serves both as an iteration statement and as simple parameterless subprogram call. In its simplest form which we have seen,

```
              PERFORM L1.    or.    PERFORM L1 THRU Ln.
```

it causes execution of designated paragraph (L1) or sequence of paragraphs (L1 thru Ln) as a simple parameterless subprogram.

The other forms of PERFORM:

```
              PERFORM L1 THRU Ln      k TIMES
```

serves to call the subprogram repeatedly k times. The statement:

```
              PERFORM L1 THRU Ln UNTIL < condition >.
```

iterates execution of subprogram until the condition evaluates to true.

The statement:

```
      PERFORM L1 THRU Ln
             VARYING I FROM I1 BY S1 UNTIL < condition-1 >
             AFTER J FROM I 2 BY S2 UNTIL < condition-2 >
             AFTER K FROM I 3 BY S3 UNTIL < condition-3 >
```

allows repeated execution of the subprogram with from one to three indices moving through integer ranges. In the above statement, index K cycles completely for each step in the value of J and so on.

In addition to the basic statement sequence-control structures mentioned above, many COBOL statements provide for execution of one or more statements when a special condition arises during execution of the base statement. For example each arithmetic statement may contain a suffix designating actions to be taken in case of a size error, an error caused by the result of the arithmetic operation being too large to fit in the designated result variable location. Thus the statement:

ADD A TO B ON SIZE ERROR PERFORM ERR-PARA -1 .

would cause execution of subprogram ERR - PARA - 1 should the sum of the values of A and B exceed the space allocated for B.

Other conditional checks include the end-of-file checking on READ statements and end-of page checking on WRITE statements.

String Manipulation

COBOL offers string manipulation features through STRING, UNSTRING and INSPECT verbs.

STRING and UNSTRING verbs are designed to facilitate transfer of data from several sources into one destination and from one destination to many destinations, respectively.

Example 1

Assume that we want to print a report which lists a customer name in column 5-25, a city name starting with column 31, one blank space and then the PIN code. The source of data is CUSTOMER-RECORD with the following description.

```
01    CUSTOMER-RECORD.
02    CUSTOMER-NAME       PIC X(20)
02    COST-ADDRESS        PIC X (100).
02    CITY -STATE         PIC X (20)
02    PIN                 PIN 9(6)
```

The data CITY-STATE is recorded such that the city name is followed by a comma a space, and then the state name. e.g., AHMEDABAD, GUJARAT. The output record is described as:

```
01    OUT-REC              PIC X(132).
```

We use STRING verb as follows:

```
MOVE SPACES TO OUT - REC
MOVE 5 TO STARTING - PLACE.
STRING CUSTOMER - NAME DELIMITED BY SIZE.
        CITY - STATE DELIMITED BY
        SPACE
        PIN DELIMITED BY SIZE
INTO OUT - REC WITH POINTER AT STARTING - PLACE
```

Example 2

Suppose the data is recorded in free from (without predefined fields) as follows:

VIJAY D SHAH, 3,12,2.75

ANAND K TIWARI, 4,15,3.25

Notice that the name fields are separated by one or more blank spaces, the commas separate the remaining three fields. We would like to move these data fields to the following fixed format record:

```
01   STUDENT-DATA.
     02   FIRST-NAME          PIC X(20).
     02   MIDDLE-NAME         PIC X(15).
     02   LAST-NAME           PIC X(20).
     02   CATEGORY            PIC 9.
     02   UNITS-REGD          PIC 99.
     02   GPA                 PIC X(4).
```

Assuming that the source data is in

```
01   FREE-FORM-RECORD        PIC X(132).
```

We can write:

```
UNSTRING FREE-FORM RECORD

         DELIMITED BY ALL SPACES OR ',',
INTO     FIRST-NAME
         MIDDLE-NAME
         LAST-NAME
         CATEGORY
         UNITS-REGD
         GPA.
```

At times we need to access and manipulate individual characters in a field. COBOL provides INSPECT verb to accomplish such character manipulations. The following examples illustrate the use of INSPECT verb:

1. Suppose we want to replace all leading blanks by zeroes in field called AMOUNT.

   INSPECT AMOUNT REPLACING LEADING ' ' BY '0'

2. Count the number of dollar signs in TEST and replace all dollar signs after the first by asterisks:

   INSPECT AMOUNT TALLYING COUNT-A FOR ALL '$'
           REPLACING ALL '$' BY '*' AFTER INITIAL '$'

Advanced File Structures

COBOL supports Indexed and relative files in addition to the normal sequential files. Sequential file organisation indicates that the records in the file are positioned in a sequential order according to one of the data fields in the record. Indexed file organisation is the one in which the records are filed sequentially but a table is available which identifies the location of the groups of records, thereby reducing the access time. Relative file organisation is such that the logical order and physical order do not necessarily correspond with one another. For such file a technique or rule is required to locate the record

Sequential Files: In COBOL, the sequential file can be opened for input, output, input & output and extend operations. When a file is opened for input & output operation, COBOL allows replacement of an existing record with the help of REWRITE verb. EXTEND mode can be used to add records at the end of a sequential file.

Indexed Files: In order to use indexed files the SELECT statement in the ENVIRONMENT DIVISION has to include following details:

```
SELECT < file-name > ASSIGN TO DISK
        ORGANISATION IS INDEXED
                        | SEQUENTIAL |
        ACCESS MODE IS | RANDOM      |
                        | DYNAMIC    |
        RECORD KEY IS < data-name >
        [ALTERNATE RECORD KEY IS < data-name-2 > [WITH DUPLICATE]]
```

In this format, ACCESS MODE clause specifies the way in which records in the file will be accessed. ACCESS MODE IS SEQUENTIAL specifies that records will be accessed in ascending order of the record key. RANDOM option specifies that the order in which records are accessed will be controlled by the programmer. This control is accomplished by moving the value of the key of the desired record into the RECORD KEY field and issuing an input-output command (READ, WRITE, REWRITE, DELETE). The DYNAMIC option allows the programmer to change at will from sequential access to random access using appropriate forms of input-output statements.

RECORD KEY references a data-name which must be a field within the record description of the file. When the ALTERNATE RECORD option is used, we access the records either on the basis of the prime key specified in the RECORD KEY clause or on the basis another ALTERNATE RECORD KEY. The DUPLICATES phrase specifies that the value of the associated alternate record key may be duplicated with any of the records in the file.

An indexed file can be opened as INPUT, OUTPUT or I-O. Reading records from an indexed file is accomplished using one of the two formats:

```
READ < file-name > [NEXT] RECORD [INTO < indentifier >]
        [AT END < imperative statement >].
READ < file-name > RECORD [INTO < identifier >]
        KEY IS < data-name
        [INVALID KEY < imperative statement >]
```

Relative files: The relevant ENVIRONMENT DIVISION format for relative files is as follows:

```
SELECT < file-name > ASSIGN TO DISK
        ORGANISATION IS RELATIVE
                        | | SEQUENTIAL [RELATIVE KEY IS < data-name >]
        ACCESS MODE IS | | RANDOM     |
                        | | DYNAMIC   |   RELATIVE KEY IS < data-name >
```

Records are read from a relative file using one of the two formats:

    READ < file-name > RECORD [INTO < identifier >]
        [AT END < imperative-statement >]
    READ < file-name > RECORD [INTO < identifier >]
        [INVALID KEY < imperative statement >]

Data Base Management Systems: In order to provide interface with Data Base Management Systems (DBMS), manufacturers offer COBOL Data Manipulation Language (DML) processors which include enhanced instruction set to carry out data manipulation operations through COBOL programmes COBOL DML processors provide natural interface to both network and relational data base management systems.

Report Writer Feature

Report writer feature of COBOL facilitates production of reports by specifying the physical appearance of report rather than requiring specification of detailed procedures necessary to produce the report. The report writer is part of the COBOL language and can be incorporated in any programme.

To use report writer feature, the ENVIRONMENT DIVISION and DATA DIVISIONS of the programes should include the description of the desired report file an its format. For example the description of the typical report file to generate invoice summary report may have the following description.

    ENVIRONMENT DIVISON entry :

    FD SUMMARY-FILE
        LABEL RECORDS ARE STANDARD
        REPORT IS INVOICE-SUMMARY.

This description is same as that for any file except that REPORT is clause is used in the place of DATA RECORD IS clause.

The DATA DIVISION entries describing the report should be described in a new section REPORT SECTION, immediately following the WORKING-STORAGE SECTION. The Report Description (RD) entry similar to FD must be used to describe the report details as shown below:

    REPORT SECTION.
    FD INVOICE -SUMMARY
        PAGE LIMIT IS 50 LINES
        HEADING 3
        FIRST DETAIL 5
        LAST DETAIL 45.
01 TYPE IS REPORT HEADING
        NEXT GROUP NEXT PAGE.
    02   LINE NUMBER IS 8 COLUMN NUMBER IS 25
         PICTURE IS A(24)
         VALUE IS 'ABC TEXTILE COMPANY LTD'
    02   LINE NUMBER IS PLUS 2
         COLUMN NUMBER IS 30
         PICTURE IS X(20)
         VALUE IS 'AHMEDABAD - 380015

```
01      TYPES IS PAGE HEADING


01      INVOICE-DATA TYPE IS DETAIL


01      TYPE IS PAGE FOOTING


01      TYPE IS REPORT FOOTING
```

It may be noted that each 01 level entry in the above example introduces a report group in a manner similar to that of record descriptions in any ordernary file.

In the PROCEDURE DIVISION, the verbs INTIATE, GENERATE and TERMINATE can be used to obtain the report as illustrated below:

```
        PROCEDURE DIVISION.
            OPEN INPUT IN-FILE
                      OUTPUT SUMMARY-FILE.
        MOVE 'NO' TO END-OF-DATA.
        READ IN-FILE RECORD AT END MOVE 'YES' TO END-OF-DATA.
        INITIATE SUMMARY-REPORT.
        PERFORM PREPARE-REPORT UNTIL END-OF-DATA='YES'.
        TERMINATE SUMMARY-REPORT.
        CLOSE IN-FILE SUMMARY-FILE.
        STOP RUN.
PREPARE-REPORT.
        GENERATE SUMMARY-REPORT.
        READ IN-FILE RECORD AT END MOVE 'YES' TO END-OF-DATA.
```

This program reads an input file, IN-FILE consisting of invoices and generates the report file, SUMMARY-FILE, as per the description given in the REPORT SECTION. The verbs INITIATE and TERMINATE are used to initiate and terminate the report generation process respectively.

Screen Handling

Recent versions of COBOL processors screen handling as one of the attractive features which facilitates development of on-line interactive systems with convenient screen formats. Normally such feature is offered through new SCREEN SECTION in DATA DIVISION following the WORKING-STORAGE SECTION. In this section the format of desired screen layout alongwith positions where input data is to be accepted or output data to be displayed is

described. For example the following SCREEN SECTION entry TITLE-SCR would display the titles at the specified line numbers and column positions of the screen. DISPLAY TITLE-SCR statement of PROCEDURE DIVISION would not only display these details but also displays the values of the data items referenced.

SCREEN SECTION.

01   TITLE-SCR

      02   LINE 5   COLUMN 5 REVERSE VIDEO VALUE 'ITEM CODE'

      02   LINE 5   COLUMN 15 PIC 9(6) FROM ITEM-CODE.

      02   LINE 8   COLUMN 5 REVERSE VIDEO VALUE 'DESCRIPTION'.

      02   LINE 8   COLUMN 20 PIC X(24) FROM DESCRIPTION.

      02   LINE 10 COLUMN 5 REVERSE VIDEO VALUE 'QUANTITY'.

      02   LINE 10 COLUMN 15 PIC 9(4) FORM STK-QTY.

01   ENQ-SCR

      02   BLANK SCREEN.

      02   LINE 5 COLUMN 5 BLINK VALUE 'ITEM CODE'?

      02   LINE 5 COLUMN 15 PIC 9(6) TO ITEM-CODE.

In this example, when DISPLAY TITLE-SCR is executed, the titles ITEM-CODE, DESCRIPTION and QUANTITY will appear in reverse video at line numbers 5,8 and 10 respectively all starting from column number 5. Values of the data elements ITEM-CODE, DESCRIPTION and STK-QTY are also displayed on the corresponding lines at column numbers 15,20 and 15 respectively as per the picture description of these items i.e., 9(6), X(24) and 9(4). Similalry when ACCEPT ENQ-SCR statement is executed, the screen is first cleared and the message ITEM-CODE? appears on line number five, starting from column 5 in blink mode. The user response is accepted from column 15 of line 5 and is assigned to the data element, ITEM-CODE. .

This briefly explain screen handling in COBOL. Extended features and variations do exit from compiler to compiler.

17.7 SUMMARY

In this unit we have discussed programming in COBOL. After introducing briefly COBOL in the beginning, the actual programming steps starting from Identification Division to Procedure Division, were discussed. We have also developed some simple programmes as examples which would hlep you for writing elementary programmes. Towards the end, we have also discussed screen handling, which is an advanced and attractive feature of COBOL.

17.8 SELF-ASSESSMENT EXERCISES

1. What kind of information do you need for feeding into 'Environment Division' details Explain with suitable examples.

2. What are the COBOL verbs, explain thier place of use in the programming giving appropriate examples.

3. Write a simple programme in COBOL for preparing payroll of employees of your organization.

20.9 FURTHER READINGS

American National Standard Programming Language COBOL-X3, 23-1974, published by ANSI

Micro Soft COBOL Compiler User's Guide, Micro Soft, Redmond, USA.

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Philippakis and Kazmier, 1978. *Information Systems through COBOL*, 2nd Edition., McGraw Hill Kogakusha Ltd.: Tokyo.

Elder, John 1984, *Construction of Data Processing Software*, Prentice Hall International Englewood-Cliffs.

M.B.A. DEGREE EXAMINATION, DECEMBER 2010.

First Year

Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours

Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Answer any THREE of the following.

1. (a) Classification of computers.
   (b) Explain :
      (i)   @ FV
      (ii) @ PMT.
   (c) Purpose of computerised inventory system.
   (d) Symptoms of virus infection.
   (e) Patents of software.
   (f) Classification of information.
   (g) Expressions.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE of the following.

2. Discuss the issues of computer–aided–decision making. Explain various auxiliary storage devices.
3. Discuss the social dimensions of computerisation.
4. Describe the statistical data required for Human Resource Management Decisions. Explain the use of computers in Human Resource Management.
5. Explain how a computer purchase/sale is a contract.
6. Discuss Anthony's and Zani's frameworks for MIS. Explain the role of MIS at various management levels.
7. Explain :
   (a) Decision tables
   (b) Logical system design and
   (c) Advanced file structures.

SECTION C — (1 × 15 = 15 marks)

Compulsory.

8. In August 1992 the House Judiciary Committee recommended that Attorney General appoint an independent counsel to investigate alleged criminal conduct by the Department of Justice in its dealing with the Washington based software firm Inslaw Inc. High level Justice Department officials were accused of being involved in contract violation, coercion and theft of Inslaw's program promise.

In 1992 Inslaw had agreed to install promise / in 94 U.S. Attorney's offices over three years at a total cost of $ 10 million. High level officials of the Justice Department had allegedly taken possession of the software and distributed it illegally to law enforcement agencies around the world, had deliberately ignored Inslaw's propriety rights and collected to violate the contract with Inslaw. To make matters worse investigators found that friends of officials in the Justice Department were allowed to sell the software for a profit, resulting in losses of millions of dollars for the software company. When Inslaw threatened to take action the Justice Department carried out a Campaign of litigation and intimidation intended to drive Inslaw, a small company with fewer than 55 employees out of business. The Justice Department is responsible for leading the change against people who engage in ethical violations. In this case it stands accessed of serious violations.

(a) What are some ethical violations in this case?
(b) What steps such as Inslaw can take to protect itself from such injustice?

EXECUTIVE M.B.A. DEGREE EXAMINATION, DECEMBER 2010.

First and Second Years

Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours　　　　　　　　　　　Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)
Answer any THREE of the following.

1. (a) Personal computer.
   (b) Computer based inventory system.
   (c) Computer viruses.
   (d) Control system.
   (e) COBOL.
   (f) Computers for generation of revenue function.

SECTION B — (3 × 15 = 45 marks)
Answer any THREE of the following.

2. Examine the role of computers in management.
3. How do you use computers in HRM?
4. What are the legal dimensions of computers?
5. Examine the development life cycle of a system.
6. Explain the social implications of computers.
7. Discuss different types of computer programming languages.

SECTION C — (15 marks)
Case Study: Compulsory.

8. An important travelers besiege an airport ticket counter in a Southern China boom team, a harried clerk scribbles seat adjustments on bounding passes and jots down passenger's names on a sheet of paper. On good days, he gets help with such chores from a mainframe computer in Beijing ,that runs China's reservation system. China is planning to invest between $ 150 billion and $ 200 billion in both infrastructure and information , systems and is seeking the help of Western Companies to achieve this goal.

   A Western Company, which set up shop in China in 1990 is playing an active role in helping the Chinese Government. Help the company in the analysis and design of an information system that helps process pay roll, administrative functions and decision making.

M.B.A. First Year DEGREE EXAMINATION, JUNE 2010.
Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours   Maximum : 75 marks

SECTION A — (3 x 5 = 15 marks)
Answer any THREE of the following.

1. (a) Levels of information handling.   (b) Disk operating system.
    (c) Functions of financial systems.   (d) Trojen Horse and worms.
    (e) Copy right of software people.
    (f) Classification of information.
    (g) Constants and variables.

SECTION B — (3 × 15 = 45 marks)
Answer any THREE of the following.

2. Explain the role of computers in management. Explain different types of applications software.

3. What is an inventory? What are its characteristics? Explain the design of an inventory system with a suitable example.

4. What is perverse software? Explain the major activities in the protection and treatment of computer viruses.

5. Explain the legal aspects of use of computers.
Discuss the tortions liabilities in use of computers.

6. Explain
(a) Cost of information and (b) Value of information. Explain the various stages in the cycle of a computer based information system.

7. What are subprograms? Explain the two kinds of subprograms. Explain the structure of a COBOL program.

SECTION C — (1 × 15 = 15 marks)
Compulsory

8. · At Viacom International, the New York based parent of MTV, Nicklodeon and other entertainment interests the CFO teamed with executives from, sales, marketing and contracting to lead the company in new directions. Because financial processes are so intertwined with the processes of other departments top managers felt that redesigning finance should ideally be part of a company - wide comprehensive reengineering project. Viacom targeted its financial systems to find a better way to handle the financial reporting of its wholly owned subsidiaries which it is acquiring at the rate of about three every year.

The company plans to develop a system which reduces paper pushing and facilitates the electronic transmission of transactions from are decision maker to the next. Another goal of the company is to build financial systems that give decision makers time to analyze data rather than spending their time collecting it.

(a) Identity the reasons why financial systems are excellent tools for facilitating decision making.

(b) Explain why financial information systems were at the centre of initiating change at Viacom.

EXECUTIVE M.B.A. DEGREE EXAMINATION, JUNE 2010.

First and Second Years

Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours   Maximum : 75 marks

SECTION A — (3 x 5 = 15 marks)

Answer any THREE of the following.

1.   (a) Role of computers in management.

(b) Operating systems.

(c) Computerised General Ledger System.

(d) Specific legislation on privacy.

(e) Classification of information.

(f) Subprograms.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE of the following.

2. Explain different types of software. Explain the main features of LOTUS 1-2-3.

3. Explain the characteristics of inventory. Explain the design of an inventory system with a suitable example.

4. What is perverse software? Describe the characteristics of computer viruses. Explain the methods of virus detection and removal.

5. Discuss the three models of MIS and compare them.

6. Explain the role of MIS at various management levels. What is a data flow diagram? Explain its use in system design.

7. Explain string handling functions with suitable examples. Explain the basic features of COBOL.

SECTION C — (1 × 15 = 15 marks)

(Compulsory)

8. Before embanking on integrated information system projects, top managers often know which employees are likely to be laid off. However, in an effort to with the cooperation of employees during system development, managers often provide verbal assurances of job security to employees who will be laid off a few months often after the system becomes operational. Manager often find themselves in a dilemma. Being truthful about coming layoff many interfere with employee cooperation. How would you as a manager, handle this situation?

M.B.A. DEGREE EXAMINATION, MAY 2009.

First Year

Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours

Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Answer any THREE of the following

1. (a) Personal Computer.

   (b) Spread Sheet.

   (c) Computer based financial system.

   (d) Computer virus.

   (e) Information needs.

   (f) Systems design.

   (g) Computer language.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE of the following

2. Explain the managerial applications of spread sheet.

3. Bring out inventory systems based on computers.

4. What are the applications of COBOL?

5. Distinguish between management information system and control system.

6. State the legal dimensions of computerisation.

7. Discuss the applications of computers in HRM.

SECTION C — (15 marks)

8. (Case Study)

Suppose you are diagnosing automobile engines using a system having a frame type of architecture similar to P/P. Show how a trigger condition might be satisfied for the distributor ignition system when it is learned that the spark at all spark plugs is weak.

EXECUTIVE M.B.A. DEGREE EXAMINATION, MAY 2009.

First and Second Years

Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours

Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Answer any THREE of the following.

1. (a) Language translators.
   (b) Functions in LOTUS.
   (c) Characteristics of Inventory.
   (d) Areas of Computer Virus Infection.
   (e) Value of Perfect Information.
   (f) Flow Chart.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE of the following.

2. What is a central processing unit? Explain the functions of its components. Explain secondary memory devices.

3. What are the functions of financial systems? Explain the features of financial management software :
   (a) General ledger
   (b) Sales and purchase ledgers.

4. Describe the statistical data required for Human Resource Management decisions. Explain the uses of computers in Human Resource Management.

5. Discuss the social dimensions of computerisation.

6. Distinguish between programmed and non-programmed decisions. Discuss the Anthony's and Zani's frameworks for MIS.

7. Explain various loop structures with suitable examples. Explain the table handling and report writer features of COBOL.

SECTION C — (1 × 15 = 15 marks)

Compulsory

8. The SPA on behalf of Lotus, Microsoft and Word perfect conducted a surprise said on two branches of a property management company on the West Coast for alleged violation of software copy right laws. Although the company had a policy against software copying employees of the company were violating software copyright laws and hence the company is likely to face criminal charges.

In a separate case, Lotus and Novell filed criminal charges against a married couple in Singapore after the pair was found guilty of trademark and copy-right infringement in a civil suit. The software companies obtained a court order freezing 90,000 in personal assets belonging to the couple, who reportedly sold thousands of illegal copies of software throughout Asia.

(a)   If a company has a well publicized written documents outlining its policies against software piracy that company should be protected from infringement liabilities. In such a case if an employee is caught violating software piracy policies, the employee should be sued, not the company. Discuss.

(b)   The personal possessions of an individual should not be taken even if that individual is found guilty of ethical violations. Discuss.

M.B.A. FIRST YEAR, DEGREE EXAMINATION, DECEMBER 2009.

Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours

Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

1. Answer any THREE of the following.

   (a) Uses of personal computer.

   (b) Computer software.

   (c) Use of computers in management functions.

   (d) Computerised payrole system.

   (e) Informational needs of management.

   (f) Systems analysis.

   (g) Machine language.

SECTION B — (3 × 15 = 45 marks)
Answer any THREE of the following.

2. Discuss the process of designing computer programme.
3. How does information system help management?
4. What are the Social Dimensions of computerisation?
5. Bring out the features of computer based inventory system.
6. What are the managerial applications of spreadsheet?
7. Describe the role of computers in solving managerial problems.

SECTION C — (15 marks)
Case Study

8. Reliance Fresh (RF) retailing marts are planning to sell its products through it retail stores across India. Its prospective customers are the customers existing for the traditional retailers. RF wants to snatch these customers into its favour.

   How do you manage to initiate a warehouse project by using Oracle RDBMS and its associated software to implement a warehouse for this purpose?

EXECUTIVE M.B.A. DEGREE EXAMINATION, DECEMBER 2009.

First and Second Years

Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours　　　　　　　　　　　　　　　Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Answer any THREE of the following.

1. (a)　Personal computer.　　　(b) Computer based HRM.

　(c)　Computer viruses.　　　　(d) Topologies of computer networks

　(e)　Machine language.　　　　(f) LAN.

SECTION B — (3 × 15 = 45 marks)
Answer any FIVE of the following.

2.　Explain the role of computers in information management.

3.　　　State the managerial applications of spread sheet software.

4.　What are the features of computer based inventory systems?

5.　Elucidate the legal dimensions of computerisation.

6.　What are the perspectives MIS?

7.　Illustrate structured query language statements with suitable example.

SECTION C — (15 marks)
(Compulsory)

8.　Sandal, shoe, and bookmaker Deckers Outdoor Corporation recently switched to an Internet networking technology called *virtual private networks* to interconnect their global company.

Virtual private networks (VPNs) use the power of the Internet instead of using private telecommunications lines or other network links. A virtual private network is a secure and encrypted connection between two points across the Internet. It transfers information by encrypting and encapsulating telecommunications traffic into packets and sending the packets over the Internet. Most VPNs are built and run by Internet service providers. Companies that go with a VPN from an Internet service provider essentially outsource their networks to save money on having to acquire and manage their own wide area network equipment and bandwidth requirements.

Deckers　　is　　a　　$100　　million　　company　　whose 20-person office in Hoek Van Holland, the Netherlands, collaborates on product

development with its staff in Goleta, California. The VPN cost roughly $31,000 to implement and saves Deckers $10,000 per month compared with leasing their previous high-speed network connections.

"We needed a network that would serve as the foundation for our international expansion," says Steve Miley, MIS director at Deckers. "It will be critical ... because our offices will use it to make sure projects are done on time".

Employees at the two sites use the VPN to update the status of product development projects through Lotus Notes groupware databases. The VPN supports Notes' ability to replicate databases of project information at each work site, which is crucial to groupware support of project team collaboration.

VPN performance "is slow but workable for interactive Notes database access", Miley says. And as the quality of Internet service improves, VPN performance can only improve, be adds.

Security, a reported shortcoming of virtual private networks, is improved with NetFortress software from Fortress Technologies. It automatically changes encryption keys every 24 hours. "We feel, very secure with their products on our network", he says.

Offices for production management in Hong Kong, Mexico, and Macao will be added to the VPN this year, Miley says. Those sites currently use expensive international telephone calls to access servers in Goleta. Desktop videoconferencing over the VPN, to cut international travel costs, is also planned.

Deckers doesn't mind being among the first to implement a virtual private network. "VPNs are here to stay", Miley says. "And we're on the leading edge, not the bleeding edge".

Questions :

(a)   What are the business benefits of Deckers' switch to a virtual private network?

(b)   What can be done to overcome several limitations of virtual private networks?

(c)   Does it make business sense for any company to use the Internet as their private telecommunications network? Why or why not?

EXECUTIVE M.B.A. DEGREE EXAMINATION, MAY 2008.

—I & II Year Executive M.B.A.

Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours   Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Answer any THREE questions.

1. (a) Primary memory and secondary memory.
    (b) Application software.   (c) Functions of financial systems.
    (d) Computer and politics.   (e) Recovery of damaged files.
    (f) Programmed and non-programmed decisions.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE of the following.

2. Distinguish between primary memory and secondary memory. Explain input and out devices four each.

3. Describe various capabilities of a spread sheet software. Explain its use in solving managerial problems with suitable examples.

4. Explain the functions of financial systems. Explain how the general ledger system can be implemented an a computer.

5. Define computer virus. What are its characteristics? Describe the measures for protection and treatment of computer viruses.

6. Explain the structure of MIS. Distinguish between programmed and non-programmed decisions. Explain the purpose of an information system.

7. Explain the tasks in the analysis and design of a CBIS.

SECTION C — (15 marks)

8. This question is compulsory.

In a manufacturing company of 2000 employees, a new systems group of four professionals started work on a complete marketing, forecasting, production and personnel MIS. They worked closely with the managers for nearly a year on the design of the MIS. The change over to the new computerized system was carried out over a two-week period so that workers could be shifted to their new jobs and trained for the new operations, Within a month confusion was rampart. Sales orders were misplaced, production was jammed up and the personnel update file was a mixture of obsolete and new update cards. Both the systems designers and managers felt that the MIS design was an efficient are, well within the capabilities of the employees to implement.

   (a) Define the problem and its cause as you see it.

   (b) Suggest several alternative solutions.

M.B.A. FIRST YEAR, DEGREE EXAMINATION, MAY 2008.
Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours　　　　　　　　　　　　　Maximum : 75 mar

SECTION A — (3 × 5 = 15 marks)

1. Answer any THREE of the following :
   (a) Explain how Internet Technologies make customers focus of a business.
   (b) What are the quality attributes of information?
   (c) Explain DBMS features.
   (d) Describe the system approach.　　　/
   (e) Types of computers.
   (f) Explain system software.
   (g) Explain structure of MIS.

SECTION B — (3 × 15 = 45 marks)
Answer any THREE of the following.

2. Explain role of computers in management.
3. Synthesise the different frameworks of MIS.
4. How can Internet and Intranets support Human Resource Management in a business?
5. Could the interactive marketing process on the Internet be a model for changes in mass marketing, direct marketing and other types of marketing? Explain.
6. Discuss about computer viruses.
7. Explain legal dimensions of computerization.

SECTION C — (15 marks)

8. Case Study :
   Company : Camelot Music, based in North Canton, Ohio, is a privately held mall-based retailer of music, CDs/cassettes, with 5,000 employees and 310 stores in the United States.

   The problem : Remain competitive with larger retailers, such as Best Buy and Circuit City, as well as smaller mall-based stores, by offering pricing schemes that vary by store and competitive situation, and discounts to frequent customers.

The solution : Use variable-pricing software and sophisticated methods to attract and retain customers.

The IT infrastructure : Richter Systems International's Automated Merchandising System runs on a Hewlett-Packard 9,000 server. Camelot's data warehouse runs on an ICL Gold Rush Mega server, informix database, and micro strategies DSS software.

Costs of technology to solve business problem : Between $ 750,000 and $1 million.

ROI/Paybacks : Objective is to increase sales by at least one-tenth of 1 percent, which would garner a payback in a little more than two years.

To Charlie Marsh, CIO of Camelot Music, competitive pricing involves more than slashing a buck off a CD here and there. To vie effectively with retailing giants and other mall shops, Marsh uses information technology to tailor Camelot's pricing structure according to region, store, and competitive situation. Camelot also awards discounts to frequent customers.

One key to success with such variable pricing is an enterprise pricing structure, says Judy Hodges, applications and information access research manager for International Data Corporation. The need for consistency is a major reason that Camelot Music picked Richter Automated Merchandising Systems (RAMS) software.

In the past, Camelot executives worried little about Best Buy, Circuit City, and other mass-market retailers, which sold few of the music CDs and cassettes that are Camelot's bread and butter. About three years ago, however, the rules of the game changed. Best Buy began selling Music recordings as a "loss leader," charging consumers $2 to $5 less than shops such as Camelot in order to attract consumers to higher-ticket electronics products. The retailers' strategy "drove 10 points out of our margin," says Marsh.

With the big retailers changing the competitive field, Camelot had to reinvent itself and offer better pricing just to stay in the game. Basing pricing on whatever criteria is appropriate – competition within or outside a mall, as well as no competition in some regions – was key.

Camelot installed RAMS, which runs on an HP 9000 Enterprise Server Camelot also operates a sophisticated customer marketing system, which runs on data warehousing software. As part of ICL's Corema customer relationship marketing system, Camelot's "repeat performer" program encompasses 2.25 million names of frequent buyers, to whom Camelot issues $5 coupons good toward purchases, on their next store visit. "It's like an airplane frequent flyer program," says Marsh.

Corema manages customer loyalty schemes, manages and monitors promotions, and supports sophisticated predictions of customer purchase patterns. Corema also enables Marsh to perform various market-based analyses, including calculating the success of regional promotions by costs and margin percentage increases.

Payback from Corema, which Camelot deployed in 1997 after nine months of development, should be quick. If the frequent buyer program increases sales by one-tenth of 1 percent, the system will pay for itself in two years. Marsh expects even more of a sales boost than that from 1,00,000 mailers he sent out last November to customers in Camelot's database.

In an earlier test, within 30 days of mailing a 10 percent discount coupon to about 6,000 customers more than 70 percent of those customers had returned to the store, and the average purchase per customer had almost doubled what it normally was. Within two months, more than 90 percent of customers had come back to the store, with the same purchase pattern.

Case Study Questions :
(a) How could Camelot Music have used a systems approach to solving their business problems?
(b) Do you agree with Camelot's solutions to their business problems? Why or why not?
(c) What else would you recommend that Camelot do to improve their business situation? How could information technology help?

EXECUTIVE M.B.A. DEGREE EXAMINATION, DECEMBER 2008.

Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours

Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

Answer any THREE of the following.

1. (a) Secondary memory devices.

   (b) Functions in LOTUS.

   (c) Purpose of computerised inventory control system.

   (d) PERVESE software.

   (e) Copyright aspect of use of computers.

   (f) Value of perfect information.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE of the following.

2. Explain in detail the block diagram of a computer.

3. Explain the capabilities of spread software and its use in solving several types of managerial problems with suitable examples.

4. Define inventory. What are its characteristics? Design a computer based inventory system with a suitable example.

5. Explain how a computer purchase/sale is a contract. Mention situations where liability arises with regard to computers even though there is no contract.

6. Explain the role of MIS at various management levels. What are the desirable characteristics of MIS?

7. (a) Explain the concept of decision table, decision tree and structured english in describing the processing logic.

   (b) Explain the table handling features of COBOL with suitable examples.

SECTION C — (15 marks)

8. This question is compulsory

   (a) A middle manager receives a monthly report on the number of hours worked by the employees in his unit. A top manager receives a report in accidents that occurred on the factory floor because of safety violations. Which of these two is a summary report and which is an exception report? Discuss.

   (b) Why does an organisation needs different types of information systems to meet its information needs? Does an organisation need all the different types of systems or does it depend on the information needs of the organisation? Discuss.

M.B.A. DEGREE EXAMINATION, DECEMBER 2008.
First Year
Paper VI — INFORMATION MANAGEMENT AND COMPUTER APPLICATIONS

Time : Three hours   Maximum : 75 marks

SECTION A — (3 × 5 = 15 marks)

1. Answer any THREE of the following :

    (a) What are the features of spreadsheet software?

    (b) What is application software?

    (c) What are the uses of computer applications?

    (d) Programmed Vs Non-programmed decisions.

    (e) Explain the block diagram of personal computer.

    (f) Explain the social dimensions of the computers.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE of the following.

2. Discuss the role of computers in management.

3. (a) How to create pivot table and scenario in the spreadsheet software?

    (b) Explain statistical functions usage in spreadsheet software.

4. Explain steps in system analysis and design.

5. Explain the types of viruses attacked to computer programme.

6. Write about application of COBOL.

7. Discuss the features of computer based inventory system.

8. Explain HRIS.

SECTION C — (15 marks)

9. Compulsory.

Your computer has taken a leap closer to taking dictation. Two continuous speech recognition (CSR) products—software that can convert normal speech into words on a screen—are now on the market. Naturally Speaking, by Dragon Systems, and ViaVoice from IBM. A third company—Lernout & Hauspie, which recently bought Kurzweil Applied Intelligence and received a $45 million investment from Microsoft, promises to have its speech recognition software out soon.

For end users and IS managers, here are the strengths and challenges of speech-recognition software :

Productivity improvements : Larry McCally, district service manager at the Chevrolet Motor Division of General Motors Corp., in Graham, Washington, bought Naturally Speaking to use in his home-based office because he's a slow typist. He's timed his productivity gain: "I type 30 words a minute, tops" he says "Now [with Naturally Speaking] I can do 60 to 65 words a minute. It 's so much faster, it blows me away."

The ability to build in "macro" instructions is also a big productivity booster. Dr. Gary Flashner, an emergency room physician at Wayne Memorial Hospital in Honesdale, Pennsylvania, uses IBM's ViaVoice to record medical records. If, when examining a heart, he finds it normal, he says into his microphone, "Heart OK," which starts a macro that comes out on the computer screen as: "Heart : regular rate and rhythm, no murmurs." Considerably longer macros can also be programmed.

Avoid workplace injuries : Frank Ricci, vice president of Fred Ricci Tool Co. in Cranston, Rhode Island, says he developed carpal tunnel syndrome because of his extensive use of the keyboard for computer-aided design. The symptoms were relieved after he began using IBM's VoiceType discrete speech software, which cut his keystroking by 70 percent. Though he hasn't used ViaVoice, he says it should be at least as beneficial, and probably much more so.

Helping disabled workers : Disabled people already have embraced discrete voice recognition technology, despite its limitations. They're likely to be happy to move on to CSR. Dorsey Ruley, a senior product manager at Ameritech, Inc., in Chicago, is a quadriplegic. He has a totally voice-activated workstation using Dragon Systems' discrete speech software, Dictate. He can dictate 40 to 45 words per minute and expects that when he starts to use Naturally Speaking, he'll boost that to at least 120 words per minute.

Accuracy : Accuracy still leaves something to be desired. Someone who speaks distinctly can get an accuracy rate in the low 90 percent range. Renee Griffith, of Zephyr Speech-Recognition Systems, says it's possible to get a 95 percent accuracy rate. The problem : Even at 95 percent that's still a lot of inaccurate words. But accuracy can

approach 99 percent with continued use, as the software learns to interpret your way of speaking, and adds more words to its vocabulary, which starts at 32,000 words and can be expanded to 64,000 words for ViaVoice.

Hardware requirements : For handling speech processing on PCs, the key factors are processing power and memory. Naturally Speaking and Via Voice have minimum requirements of 166-MHz microprocessors and 32 MB of memory, although many users, are finding that 200-MHz processors and 64-MB of memory in the threshold for good performance.

What can't be denied is the inherent appeal of speech recognition software. The ability to tell a computer what you want it to do rather than typing in cryptic commands is intuitive and natural. Today's speech recognition software has its limitations, but the new products are a tremendous improvement, and more speech-enabled software is being developed. For example, ViaVoice enables you to dictate into Microsoft Word, Lotus WordPro, and Lotus 1—2—3, and is included in Lotus SmartSuite. That prompts Griffith to say, "Within a few years, everyone will he talking to their computers."

Case Study Questions :
(a) What are the benefits and limitations of continuous speech recognition software?
(b) What are the best business and other uses for CSR software?
(c) Would you like to use CSR software for word processing and other applications? Why or why not?
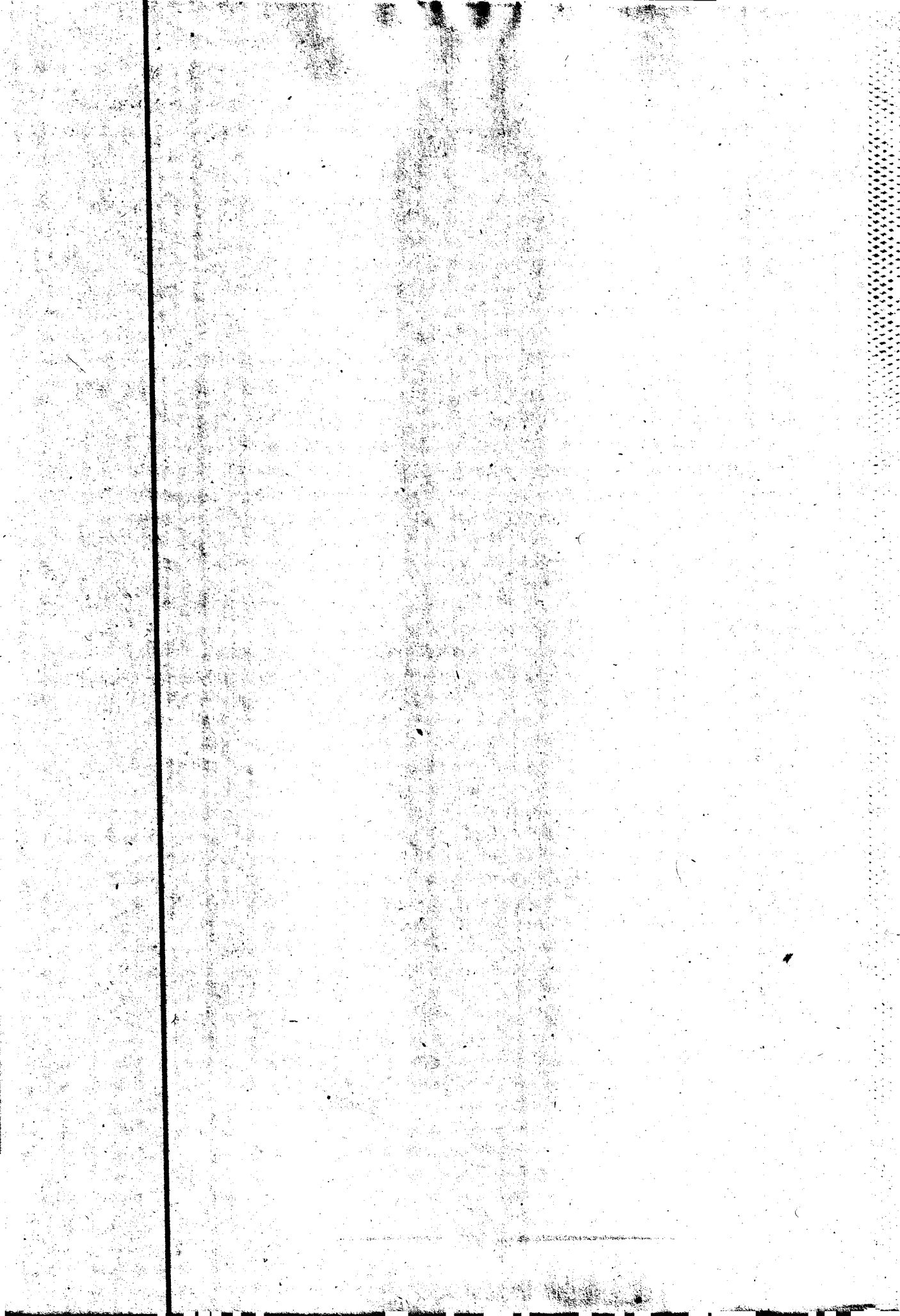
అధ్యాపకుల, విద్యార్థుల సలహాలు, సూచనలు :

అధ్యాపకులు, విద్యార్థులు ఈ స్టడీ మెటీరియల్‌కు సంబంధించిన సలహాలు, సూచనలు, ముద్రణ దోషాలు తెలియపరచినచో, పునర్ముద్రణలో తగు చర్యలు తీసుకొనగలము.

తెలియపరచవలసిన చిరునామా :

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Course	Year	Paper No. & Title
M.B.A.	1st Year	Paper-VI, Information Management and Computer Applications